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REPORT

OF THE

COCHITUATE WATER BOARD,

TO THE

CITY COUNCIL OF BOSTON,

FOR THE YEAR 1853.



BOSTON:
1854.
J. H. EASTBURN, CITY PRINTER.

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E. S. Chesbrough

July 24, 1856

REPORT.

Office of the Cochituate Water Board.

Boston, January 15, 1854.

To the City Council of Boston.

The Cochituate Water Board respectfully submit, in compliance with an Ordinance of the City Council, their Annual Report for the year 1853.

Supply of Water.

The experience of the past year fully agrees with that of previous ones, in confirming the anticipations originally formed, of the entire sufficiency of the Water Works for affording an ample supply of water, for "all the public, domestic and manufacturing uses of the inhabitants." The supply in Lake Cochituate was quite abundant, the quantity wasted at the outlet dam having been more, by upwards of a hundred million of gallons, than what was drawn from the Brookline Reservoir for the consumption of the city.

A comparison of the total rain-fall during the year, as estimated from observations made at the Lake, and at the Marlborough, and Hopkinton Reservoirs, under the direction of the Water Board, with the quantity of

water received into the Lake, as stated in the returns of the several Superintendents, shows a near conformity with the original calculations of the Water Commissioners, that we might rely on receiving four-tenths of the whole yearly rain-fall on the water-shed.

The rain-fall over the whole water-shed is estimated to have been 50 inches, which would be equal to 2,069,100,000 cubic feet, or 15,528,250,000 wine gallons. The tables of the consumption of water in the city show that 3,117,939,500 gallons were drawn from the Brookline Reservoir, and the amount wasted at the Lake was 3,436,817,500 gallons, to which adding 172,000,000 as the quantity indicated by the difference of level of the water in the Lake at the beginning and end of the year, the whole number of gallons received into the Lake from the rain-fall appears to have been 6,726,757,000, or about 43 per cent. The quantity which leaked into the brick aqueduct is presumed to have been about equal to that discharged at the waste weirs, in the process of making the repairs on the aqueduct.

The gates at the outlet dam were closed on the 17th of June for the purpose of retaining, for consumption during the dry season, the water which had been previously collected. The height of the water was then 7 feet 2¼ inches above the flume, and 9¾ inches below the point of high water to which the city is authorized to raise it. The gates were kept closed until the twenty-first of November, when the fall rains had again raised it to 7 feet 4¾ inches. The lowest point to which it fell during the summer was 3 feet 2½ inches below the high water level, on the 24th of October. There then remained in the Lake 3 feet 11¾ inches, or more than one-half of the quantity which had been retained.

From the 17th of June to the 24th of October, the

rain-fall was twenty inches, being equal to 6,207,300,000 gallons on the water-shed. During the same period there was drawn from Brookline Reservoir 1,128,228,840 gallons, and wasted from the Lake 119,600,000, from which sums deducting 321,650,000, the quantity indicated by the difference of level at the two periods, the amount received from the rain-fall appears to have been 926,178,840 gallons, or about 15 per cent. of the rain-fall.

While the quantity drawn from the Brookline Receiving Reservoir annually has been constantly increasing, it will be seen, by reference to the tables in the Report of the City Engineer of the average monthly depths in the Beacon Hill and South Boston Distribution Reservoirs, that the average depths for the year have been gradually diminishing. The former having fallen from 11.01 feet in 1850 to 6.80 in 1853, and the latter from about 14 feet in 1850 to 8⅓ feet in 1853; and during the present month, since these tables were formed, the depth at the latter has for several days been but about 3 feet and under.

The great and principal cause of this is undoubtedly to be looked for in the continually increasing consumption. There are other causes, however, some of which are temporary and others permanent, and becoming more and more efficient, to which it must be in some measure attributed.

In the first place, the necessity of completing the repairs in the brick aqueduct, which were commenced in 1853, as stated in the last annual report, has required that the water should be drawn off for three and sometimes four days every week, by which the height at the Brookline Reservoir was lessened about four feet on an average, and in the city it has been about two feet less than it would otherwise have been.

These repairs are now nearly completed, and it is hoped that the whole work will be done in May next.

The other cause is found, in the reduced capacity of all the iron mains and pipes, occasioned by the accumulation of accretions, which permanently adhere to their interior surface. The Water Board, in their report of last year, gave a somewhat detailed account of the state of the pipes in relation to this subject, and also of all the facts which they could learn in regard to the existence of the same trouble in other places, and of the efforts which had been made to ascertain their origin, and to prevent or remove them. During the year they have been carefully watched, and Professor Horsford has continued to give his very valuable services to the subject. His communication the Committee beg leave to annex and make part of their report. The extent to which these accretions have affected the discharge of water from the pipes, by diminishing their area and increasing the friction, has been satisfactorily ascertained by observations made by the City Engineer with great care on one of the thirty-inch mains across Charles River; and is found to be much greater than was anticipated. The loss of discharge under the common head of six inches was found to be upwards of twenty per cent. of the known discharge of a new main of like diameter. Similar observations made on the thirty-inch main from the Brookline Reservoir, under the ordinary head of eight feet, gave the same result. The level in the city has been accordingly reduced from this cause, usually not less than three feet.

Consumption of Water.

The quantity drawn from the Brookline Reservoir and used in the City during the year was, as has been stated, 3,117,939,500 wine gallons, being a daily aver-

age for the year of 8,542,300 gallons, and affording a supply to every inhabitant, of the present population, of fifty-five gallons daily. The quantity thus used exceeds that of the last year by more than 152,000,000 gallons. This excess seems to have been confined to the month of June and the four last months of the year, as in the other months the consumption was less than that of the corresponding months of the previous year. The difference in the consumption of the two years is probably to be attributed to the fact that during all the early months of the year the weather was much milder than the year before, and thus one great and usual source of waste of water caused by letting it run to prevent freezing in the pipes, was in a degree obviated; and during the other months, when the consumption was less than the year previous, the deficiency was probably entirely owing to the unusual amount of rain-fall, which rendered the customary use of the water for many purposes unnecessary. There is an evidence of this in the comparative consumption of the months of June and August. In the former there was hardly any rain, (0.30 in.) and the daily consumption then exceeded that of the last year by 912,817 gallons; but in the latter month, when the rain-fall amounted to the large amount of 9.40 in., the daily consumption was less than that of the previous year by 947,358 gallons.

Since the month of September the excess of consumption over the last year has been continually increasing, so that during the month of December it amounted to 2,032,582 gallons daily—the daily average for the month being 9,228,400 gallons.*

* An unavoidable delay in finishing this report at the time fixed by the Ordinance enables us to state a more inordinate excess of consumption which took place the latter part of January. The daily average continued about the same as in December until the 25th, when the cold became more intense; on that day, for

It has been deemed important to the Board to ascertain the time and places where any excess of consumption generally takes place, and more particularly to measure, with as much precision as possible, the draught at times when there would probably be the smallest quantity used, and in places where the use might be presumed to be unusually large.

In reference to the first point, the Report of the City Engineer describes an elaborate course of observations made by him. Their result will, we think, excite the surprise of the City Council, as it has that of the Water Board. The time taken was between midnight and four o'clock in the morning, October 19th. It was found that the consumption at that time amounted to 885,000 wine gallons, which was at the rate of 5,310,000 gallons in twenty-four hours; and these results were confirmed by subsequent observations. That is to say, at a period of time when the vast majority of water takers are presumed to have ceased entirely to draw any water, and when the consumption every where must have been quite a small fraction compared with that of any other part of the day, and at a season of the year when it could not have been run to waste to prevent freezing, the consumption was at a greater rate, by nearly a million of gallons a day, than was originally anticipated to be necessary for all the wants of the present population, supposing it to be 155,000. A result so extraordinary, at first led to the suspicion that there might be one or more leaks in some of the mains. A farther course

24 hours, the consumption was 11,600,000. On the 26th, it was 13,100,000. On the 28th and also the 29th, it was upwards of 14,000,000. And the average for the month has been 10,800,000. The consequence has been that the Reservoirs on Beacon Hill and at South Boston, were drained, and that at East Boston reduced at one time to 3 feet 6 inches. There was an entire failure of supply to many houses on Mount Vernon, and also on Fort Hill, and the higher parts of Broadway, South Boston.

of experiments, however, proved that this could not be the case, and that there could not be any important leak in any of the mains or distributing pipes in the streets, or in those which cross the channels to South and East Boston. An attempt was also made to ascertain the quantity discharged from the different sewers, during the same hours, and though it could not be done with entire completeness, it appeared sufficiently proved, that the consumption was more than equalled by that discharge.

In order to ascertain the quantity actually used in certain places where it was supposed to be unusually large, the Board have, during the summer of the past year, caused water meters to be placed in some of the principal hotels and livery stables, for measuring the quantity actually drawn. They have found that in one hotel there was an average daily consumption of 25,539 gallons, for 58 days—and in another, an average daily consumption of 17,441 gallons, for 70 days. By the present tariff the former paid at the rate of about one cent for 4½ hogsheads of water. In one livery stable there was a daily average consumption of 5,540 gallons for 35 horses, or about 158 gallons to each horse; in another, a daily average of 5,019 gallons for 55 horses, about 90 gallons for each horse; in another, a daily average of 2,818 gallons for 45 horses, about 62 gallons for each horse. In all these stables the hand hose was used for washing carriages, &c., and it was obvious that much of the waste could be attributed to that fact, by comparing the consumption with that in stables where no hose was used, in one of which there was a daily average of 1,666 gallons for 50 horses, about 32 gallons for each horse, and in another it was 558 gallons for 36 horses, or 15 gallons for each horse.

Waste of Water.

The Water Board regret that they have no evidence, on which they can attribute the diminished consumption, which appears to have taken place at certain periods of the year, to a more prudent use of the water than has heretofore prevailed; and they continue to be duly sensible of the necessity of repressing the wastefulness which so great a consumption during the year indicates. The quantity used has been about double what was originally, and is now, believed to be sufficient, for all the "public, manufacturing and domestic" uses of the present population; and more, by 1,300,000 gallons than was deemed ample for 250,000 inhabitants. Nearly one half of the consumption may fairly be considered as absolutely wasted. They cannot help believing that one cause of it may be found in the fact that, to a vast majority of the water takers, it has hitherto been of no injury, and that probably by them its future consequences are little appreciated, or indeed known. There is, however, even at this early period in the history of the water works, a large and increasing number on the higher part of the city who already at times feel no small inconvenience from a deficiency of supply, whose complaints are becoming more grave and well founded daily; and for which some remedy must ere long be found. The Board have effected this to some extent heretofore, by causing the effluent main of the Beacon Hill Reservoir to be closed from 7 o'clock in the evening to 6 o'clock in the morning, for the purpose of accumulating, if possible, a quantity sufficient to supply the reservoirs in the houses of those tenants, in the early part of the day. The draught, however, has been recently so great, and the quantity accumulated so comparatively small, that the supply has been entirely

insufficient, even for many houses which were provided with reservoirs; and for those which had none the relief was still less effectual. There is but a foot or two of water frequently left in the Beacon Hill Reservoir, and it sometimes stands four and even ten feet below the bottom of it; of course at those times there are but few houses in the neighborhood, where the water rises above the first floor; in many it flows but imperfectly and interruptedly even into the lowest rooms; and in some it has failed altogether.*

But far more serious consequences may be apprehended if a greater head of water cannot be kept up on the high service, and in the Beacon Hill and South Boston Reservoirs.

The whole district of South Boston is supplied by a single main of twenty inches diameter, carried under the bridge, having an inverted syphon beneath the draw. The main has hitherto continued perfectly tight and uninjured; it is however liable to accidents, and should any happen, by which the flow through it should be interrupted, that district would be entirely deprived of water, not only for extinguishing fire, but also for the ordinary purposes of life, unless a greater quantity can be retained in the reservoir than we now

* The recent extremely cold weather, and consequently inordinate consumption, has made it necessary to supply the high service by a very essential change in the mode of operating the works. It has been effected by separating a part of the City from the rest for the high service, and devoting the 30-inch main to it. This removes the difficulty on the high service. As by it, however, the low service is supplied at a level ordinarily twenty-five feet lower than the high, or about twelve feet lower than the bottom of the South Boston Reservoir, and the same distance below the level of top water in the East Boston Reservoir, it is impossible, while the separation continues, to fill the latter or get any water into the former, and it becomes necessary again to connect the two services for this purpose from time to time; but the connection cannot be continued long, lest serious inconvenience should again be felt on the high service. This mode of operating requires constant attention and labor, and also involves some risk of injuring the gates by continually moving them.

can do. And there is apprehension of similar difficulties in the high service, if the head of water cannot be kept up in the Beacon Hill Reservoir.

For the purpose of obtaining all the information which it was possible might throw any light on the subject of the waste of water, the Water Registrar was requested, in the early part of the year, to make an examination of all the water-fixtures in the several dwelling houses and other places, where the Cochituate Water is used; and to report the same to the Board. A very careful and thorough inspection was accordingly made, and the result submitted by the Water Board to the City Council.

The Water Registrar stated in his report, that he caused the premises of every water taker to be visited, the fixtures to be examined, and the various ways of using the water to be ascertained; and also an account to be taken of the places where the fixtures were out of order and the water found running to waste. He returned "a full statement of the number and kind of water-fixtures contained within the premises of all the water takers in the city" a copy of which is annexed to his report, herewith transmitted.

He also reported some prevalent modes of using the water, particularly in urinals and certain descriptions of water closets, as very objectionable, in being the cause of a great waste without any proportionate benefit to any one. That the present *use of it at all in urinals* very imperfectly accomplishes the purposes of cleanliness, and that the *hopper closet* and *self-acting closet*, require, when properly used, about nine times the quantity of water that the *pan closet* does; and that by substituting the latter for the two former descriptions, there would be a saving of 239,960 gallons daily, even supposing there were no unnecessary

waste in either. He therefore recommended that the use of the water in *urinals* and in the *hopper and self-acting water closets*, and also of the *hose in stables*, should hereafter be prohibited.

The Water Board, after due consideration of the facts communicated by the Water Registrar, fully agreed with him in the alterations proposed, and submitted the same to the City Council. An ordinance was accordingly passed proscribing the use of the hose in stables for the future, and increasing the water rate in boarding-houses (of a certain value) and hotels; with permission, however, for those having charge of them to place meters in them, and have the water rate assessed according to the quantity actually used; and also authorizing the Board to regulate the subject of water closets. The Board was also subsequently directed "to revise the present Tariff of Water Rates, and to report the same, at an early day during the ensuing Municipal year, to the City Council of Boston."

The Water Board have used and will continue to use all the means in their power to prevent the waste which prevails, by enforcing the provisions of the ordinances on the subject. It is their intention to this end, to appoint proper persons, whose special duty it shall be to ascertain, as far as possible, all places where the water is suffered to run to waste, and forthwith to report the same; and the Water Registrar will be directed at once to cut off the supply from such places, without waiting to give notice to any parties interested. And the Board have also renewed their appeals to their fellow-citizens to attend to the use of the water in their own households.

Additional Works.

If, however, their endeavors should continue to be, as heretofore, fruitless, they think that it will be necessary to supply the high service by some means which we do not now possess. Not only because common justice requires that that portion of our fellow-citizens who have been subjected, and will continue to be so, to no small share of the burdens which the introduction of the water has imposed, should enjoy all its benefits equally with the others, but for reasons in which those living on the highest part of the city are not alone interested. The danger of fire makes it an object of the deepest concern to all parts of the city.*

It is for the City Council to determine the necessity of such further supply, and also of the mode of effecting it. Three different ways have suggested themselves to the Water Board.

The first is, the laying another main to the Brookline Reservoir, by which the quantity brought into the city will be actually increased and devoted to the high service.

The second is, the employment of steam, to raise a sufficient quantity into the Beacon Hill Reservoir, which may be brought in by the present mains.

And the third is, the requiring the use of water meters by the water takers, and charging a water-rate in some proportion to the quantity of water used; by which it is thought that the waste will be prevented, and the quantity now brought in be found amply sufficient for all parts of the city. The City Engineer has been requested to report on the practicability and the cost of each of the above modes, which will be the sub-

* It would have been difficult to foresee the extent of the calamity had a fire occurred, on several nights recently, when Mt. Vernon, part of Fort Hill and of South Boston were entirely deprived of a supply of water.

ject of a special communication hereafter, if the Water Board find it necessary.

General Condition of the Works.

The general condition of the various structures at the Lake and Reservoirs, and of the brick aqueduct, mains and distributing pipes, continues to be highly satisfactory. The repairs on the aqueduct have been continued successfully during the year. The work has been exceedingly arduous, and is found to be of the most vital importance to the security of the structure. By using the English hydraulic cement, the stoppage of the leaks has been, it is believed, fully effected, though the cost has been much increased. We have every reason to believe that these highly important defects in the original construction, which had been a source of anxiety from the beginning, will be now effectually and permanently remedied. About three thousand feet, out of the fourteen thousand originally deemed necessary to be repaired, now remain unfinished. The vegetable substance which is mentioned in the City Engineer's Report as having made its appearance lately in the aqueduct, is stated by botanists to be a species of *spongilla* or *fresh water sponge.* There is probably no way of preventing its growth; it is however easily removed. The only injury it is known to do, is the clogging up the screens at the reservoirs; and on this account it has become quite troublesome.

On the subject of the accretions in the iron mains and pipes, Professor Hosford is of opinion, from his own observations from time to time, that their growth is less rapid than at first. Our experience would therefore go to confirm the opinion expressed by Mr. Mallet, in his report to the "British Association," that the rate of increment must be a decreasing one. An analysis has

been made of specimens of iron, from various pipes of the Boston Water Works, which had been more or less covered with tubercles; and also from pipes used in the Croton Aqueduct; and that at Baltimore; but there could be discovered no principle of correspondence, between the rapidity of the formation of the accretions and the relative proportion of carbon, or the proportion of graphite on the one hand, and silica and other insoluble matters on the other; or the appearance of the grain and lustre. There was, however, a striking coincidence between the specific gravities of the different specimens and the scale of accretion—the rapidity of formation of the tubercles appearing to be in a direct ratio with the specific gravity. This has thrown some light on the subject, which will be the subject of future observation. Professor Horsford is disposed to recommend a coating of hydraulic cement to protect the pipes, if, on the trial which is now making, it is found to adhere; and he states, that after the result of the experiments now in progress is known, he has no doubt that the cause of the accretions and the mode of preventing them will be ascertained.

For information more in detail of the state of the various parts of the works, the Board would respectfully refer the City Council to the full Report of the City Engineer, hereto annexed.

Extension of the Works.

The amount of Distributing Pipes, of 12, 6, 8, and 4 inches diameter, laid during the year, is 13,090 feet, and 19 Stopcocks were affixed to the same. The whole length of all the pipes, of 4 inches and upwards in diameter, including hydrant branches and bends, is now a little more than 109 miles.

The whole number of Stopcocks, 941.

The number of Service Pipes laid during the year, is 687, or 19,588 feet. The whole number, is 17,340 pipes.

The number of Hydrants established during the year is 25. The whole number is 1,185.

The whole number of leaks, which occurred and were repaired, in pipes of 4 inches and upwards, was 85; the last year, 82; in those of less than 4 inches, 260; the last year, it was 241.

Compensating Reservoirs.

The Compensating Reservoirs, at Hopkinton and Marlborough, are also in a satisfactory condition, and have fully answered the purpose for which they were designed, viz., the supplying Concord River with a quantity of water for the use of the Mills at Billerica, and also the Middlesex Canal, sufficient to compensate for supposed loss which they might sustain, by reason of our having diverted the water of Lake Cochituate from the same. The estimated amount discharged from both Reservoirs, from June 1 to October 1, was 1,413,712,000 gallons.

The natural supply of the Lake, during the same period, was 548,908,600 gallons, besides what was wasted at the natural outlet, which also continued to supply the River.

The quantity discharged from the Reservoirs was more than two and a half times greater than what would have been the natural supply of the Lake. In fact the amount actually wasted from the latter, during the months of July and August, is believed to have been nearly or quite as much as would have flowed from the Lake, during the same period, if the dam had not been built.

Lands belonging to the Water Works.

The lands and other property purchased for the City, at the time of the construction of the works, continue in the same state as at the last annual report, with the exception of a small lot which has been sold for $100 and the amount paid into the Treasury.

Receipts and Expenditures.

By the account of Receipts and Expenditures for the year, hereto annexed, the same appear to have been as follows:—

The whole amount drawn from City Treasury, - - - -		$89,854.03
From which deducting,		
Paid for Land and Water Rights, - - -	$ 1,005.00	
Paid for extension of the Works, - - -	51,327.48	
		52,332.48
Amount of current expenses, -		$37,521.55
The whole amount of receipts, (excepting receipts for water rates,) was as follows:		
For rents and sundries paid to City Treasurer, by account annexed, - -	$4,621.40	
For rents and sundries, charged in various accounts, - - -	708.29	
		5,329.69
Balance, - - -		$32,191.86

The whole cost of the Water Works to January 1, 1854, has been $5,574,323.15.

It is calculated by the Water Registrar, that the amount saved to the city the past year in the cost of maintaining the Fire Department, by the use of the Cochituate Water, has been $51,705; which added to the receipts for water-rates, &c., and from other sources, will now fully equal the interest payable on the total cost of the Water Works

Water Tenants and Water Rents.

By the Annual Report of the Water Registrar, it appears that the whole number of water takers, now entered for the present year, is 17,911, being an increase for the past year of 1,049, to which must be added 259, being for Public Buildings which have been assessed, pursuant to an order of the City Council.

The number of cases where the water has been shut off for repairs on the pipes has been 1,238, of these 1,126 have been afterwards let on.

The number shut off for non-payment of water rates was 532, and of these 459 were afterwards let on.

The number let on for the first time was 804. No abatements have been made.

The whole amount received for the year was $196,352.32, of which $2,363.88 was due for previous years.

And there has been received for letting on water previously shut off for non-payment of rates, $838; making the whole amount received $197,190.32. Of this amount $2,010.61 was received on account of Jamaica Pond.

The assessments for 1854 already amount to $180,144.31.

The estimate of receipts for the present year is $215,000.

The expenses of the office have been $2,295.17.

The Report also contains a detailed statement of the number and kind of water takers to whom the water has been supplied, and the several amounts paid; of which the following abstract has been prepared:

13,632	Dwelling-houses, - - -	$119,891.18
2,845	Stores, shops, offices, cellars, &c.,	16,006.93
283	Hotels, restaurants, and saloons,	6,459.57
480	Stables, - - - - -	6,515.38
8	Railroads, - - - -	6,527.20
2	Ferry Companies, - - -	1,006.53
16	Steamboats, - - - -	3,055.81
932	Hose, - - - - -	2,829.00
1	Motive-power, - - - -	535.51
63	Sugar Refineries, distilleries, breweries, and bakeries, - -	6,635.93
3	Gas Companies, - - -	514.47
	Other manufacturing purposes, -	16,247.23
	Public buildings, charitable institutions, &c., - - - -	1,053.83
	Shipping contract with watermen,	3,900.06
	Street Waterers, - - -	655.88
	Building purposes, - - -	609.93
	Other purposes, - - -	1,544.00
		$193,988.44

The Board also transmit to the City Council, pursuant to the provisions of the ordinance, the Annual Reports of the *City Engineer* and *Water Registrar.*

Respectfully submitted.

THOMAS WETMORE, *President.*
JOHN H. WILKINS,
HENRY B. ROGERS,
JONATHAN PRESTON,
ADAM W. THAXTER,
SAMPSON REED,
THOMAS SPRAGUE,
Cochituate Water Board.

APPENDIX.

EXPENDITURES.

STATEMENT *of all expenditures made by the Cochituate Water Board, from December* 31*st*, 1852, *to January* 1*st*, 1854.

Blacksmith Shop, for stock, &c., -	222.07
Plumbing " " " " -	56.65
Proving yard " " " -	91.63
Cartage, Boston, - - - -	292.73
" S. " - - - -	50.62
" E. " - - - -	255.12
Wagon hire, for Sup't of Iron Aqueducts, - - - -	269.75
Travelling Expenses, - - -	633.56
Salaries, - - - - -	7,835.99
Office expenses, for rent, fixtures, &c., - - - - -	1,591.85
Postages, - - - - -	30.94
Expresses, - - - - -	25.42
Stationery, - - - - -	133.89
Printing, - - - - -	646.35
Advertising, - - - -	11.38
Recording Deeds, &c., - - -	1.00
Miscellaneous Expenses, - -	279.25
Taxes, - - - - -	1,371.11
Amount carried forward,	$13,799.31

Amount brought forward,		$13,799.31
Lanterns, - - - - -	48.75	
Oil and Wicking, - - -	86.73	
Tools, - - - - - -	2,211.11	
Fountains, - - - - -	352.91	
Beacon Hill Reservoir, for labor, &c.,	480.16	
South Boston " " " "	322.51	
East Boston " " " "	327.83	
Brookline " " " "	497.65	
Aqueduct Repairs, for labor and Materials, - - - -	9,304.28	
Lake Cochituate, for labor, &c., -	213.53	
Tolls and Ferriages, - - -	163.24	
Service Pipes, - - - -	804.78	
" " Boston, - -	1,485.52	
" " S. " - - -	805.33	
" " E. " - - -	1,392.77	
Water Pipes, - - - - -	18,373.67	
" " Boston, - -	82.24	
" " E. " - - -	1,642.65	
Hydrants, - - - - -	538.93	
" Boston, - -	398.56	
" S. " - - -	3.58	
" E. " - - -	9.59	
Hydrant Boxes, - - - -	268.49	
" " Boston, - -	46.20	
Stop Cocks, - - - -	345.49	
" " Boston, - -	496.26	
" " S. " - - -	169.48	
" " E. " - - -	166.48	
Stop Cock Boxes, - - - -	268.48	
" " " Boston, - -	30.45	
" " " S. " - - -	7.65	
" " " E. " - - -	9.40	
Air Cocks, - - - - -	7.87	
Union Stop Cocks, - - -	130.00	41,492.57
Amount carried forward,		$55,291.88

Amount brought forward,		$55,291.88
Laying Water Pipes, Boston, -	413.34	
" " " S. " - -	136.07	
" " " E. " - -	624.37	
Laying Service Pipes, - - -	109.55	
Water Meters, - - - -	3,810.43	
Repairing Streets, Boston, - -	552.54	
" " S. " - -	40.33	
" " E. " - -	78.75	
" Water Pipes, - - -	20.66	
" Stop Cocks, - - -	916.03	
" Stop Cock Boxes, - -	30.10	
" Hydrants, - - -	41.22	
" Hydrant Boxes, - -	42.76	
Marlboro' Reservoir, - - -	25.25	
Whitehall " - - - -	23.05	
Rents, - - - - -	92.00	
Land Damages, - - - -	15.00	
Land and Water Rights, - -	1,005.00	
Water Works, East Boston, - -	882.28	
" " Boston, - - -	1.25	
Damages, Boston, - - - -	15.00	
Jamaica Pond Aqueduct, - -	13.50	
Cash, for sums received and paid to City Treasurer, - - -	472.73	
New Pipe Yard and Repair Shop, -	9,969.33	
Stable for horses, vehicles, &c., -	1,154.93	
Chas. R. Train, Esq., - - -	1,000.00	21,485.47
Amount carried forward,		$76,777.35

AMOUNT PAID FOR LABOR, VIZ:

Letting on and shutting off Water, -	1,394.66	
Blowing off Hydrants, - - -	651.87	
Laying Water Pipes, Boston, -	982.17	
" " " S. " - -	541.08	
" " " E. " - -	2,113.94	
Amount carried forward,	$5,683.72	

Amounts brought forward,	$5,683.72	$76,777.35
Laying Service Pipes, Boston, -	1,102.65	
" " " S. " - -	453.60	
" " " E. " - -	630.85	
Blacksmith Shop, - - - -	659.17	
Plumbing " - - - -	529.12	
Proving Yard, - - - -	2,033.95	
Repairing Streets, Boston, - -	198.47	
" " S. " - - -	12.17	
" " E. " - - -	17.88	
" Water Pipes, - -	558.41	
" Service " - - -	748.81	
" Hydrants, - - -	796.66	
" Stop Cocks, - - -	113.68	
Miscellaneous, - - - -	195.70	
Jamaica Pond Aqueduct, - - -	50.13	13,784.97
		$90,562.32
Cr.		
Marlboro' Reservoir, - - -	150.00	
Whitehall " - - - -	167.81	
Rents, - - - - - -	352.18	
Old Materials, - - - -	8.30	
Henry Richardson, - - -	30.00	708.29
Amount drawn for, - -		$89,854.03

Cash paid City Treasurer.

For Rents, &c., at Saxonville, -	244.93
" " " at Wayland, - -	196.00
" " " at Marlboro', - -	100.00
" " " at Needham, - -	13.50
" " " at Brookline, - -	39.37
" " " at East Boston, -	10.00
" an old box used for water pipes,	75.00
" Iron Pipes, &c., - - -	131.29
" Old Pipes, - - - -	231.04
" Engineering Instruments, - -	28.00
Amount carried forward,	1,069.13

Amounts brought forward,	$1,069.13	$89,854.03
For Land sold in Needham, - -	100.00	
" Sundries sold, - - - -	106.38	

AMOUNT PAID BY THE SERVICE CLERK.

For filling cisterns, - -	51.00		
" Service Pipe and laying,	1,730.14		
" Shutting off and letting on water, - - -	1,564.75	3,345.89	4,621.40
Balance, - - - - -			$85,232.63

PAYMENTS *made by the Cochituate Water Board, for unsettled claims and extension of the Works, viz :*

UNSETTLED CLAIMS.

Land and Water rights, - -	1,005.00	

EXTENSION OF THE WORK.

Main Pipes, - - - -	20,098.56	
Service Pipes, - - - -	4,448.40	
Water Meters, - - - -	3,810.43	
Hydrants, - - - - -	950.66	
Stop Cocks, - - - -	1,307.71	
Labor laying Main Pipes, - -	3,637.19	
" " Service Pipes, - -	2,187.10	
" at Proving Yard, - -	2,033.95	
New Pipe Yard and Repair Shop,	9,969.33	
Tools, - - - - -	2,046.39	
Horses, Vehicles, &c., - - -	797.76	52,332.48
Amount of current expenses,		$37,521.55

STATEMENT *of the Expenditures and Receipts, on account of the Water Works, to January* 1*st*, 1854.

Amount drawn by the Commissioners, -		4,043,718.21
" " " Water Board, of 1850,		366,163.89
" " " C. W. Board of 1851,		141,309.23
" " " C. W. Board of 1852,		89,654.20
" " " C. W. Board of 1853,		89,854.03
		$4,730,699.56
Amount paid into the City Treasury by the Commissioners, - - -	47,648.38	
Amount paid into the City Treasury by the Water Board of 1850,	8,153.52	
Amount paid into the City Treasury by C. W. Board of 1851,	5,232.38	
Amount paid into the City Treasury by C. W. Board of 1852,	15,869.12	
Amount paid into the City Treasury by C. W. Board of 1853,	4,621.40	81,524.80
		$4,649,174.76
Sundry payments by the City,	38,403.00	
Discount and interest on loans,	1,596,570.42	1,634,973.42
		$6,284,148.18
Sundry credits by the City,	884.23	
Am't received for Water Rents, &c.,	708,940.80	709,825.03
Whole cost of Water Works, to Jan. 1, 1854,		$5,574,323.15

SAMUEL HOLBROOK,
Clerk of Cochituate Water Board.

CITY ENGINEER'S REPORT.

City Engineer's Office,
Boston, Jan. 5, 1854.

Thomas Wetmore, Esq.,
President of the Cochituate Water Board:

Sir,—Pursuant to the 13th section of the City Ordinances of Oct. 31st, 1850, the following Report is made, relative to "the general condition of the Water Works," and to other matters of interest connected therewith. The same order that was followed in the last Annual Report will be observed in this.

Lake Cochituate.

The gate house, outlet dam, roads, culverts, and other structures, together with the grounds around the Lake, are all in good order.

The same precautions that were taken in 1852, to avoid having the marshes at the south end of the Lake uncovered during the warm season, were taken in 1853; and no cases of sickness, supposed to have been caused by malaria arising from these marshes, have come to the knowledge of any one connected with the Water Works.

The least average depth of water, in both divisions of the Lake, above the level of low water, (or 3 feet 10 inches above the bottom of the Aqueduct,) was that of Oct. 24th, when it was 4 feet 3 1-2 inches, or only 3 feet 2 1-2 inches below high water level, as established by the Water Act.

Brick Aqueduct and Structures between the Lake and the Brookline Reservoir.

The interior of the Aqueduct has not been cleansed during the past year, for two reasons. First, it has not been

convenient to do so, on account of the repairs that have been making in it; which are still going on, and which it is very desirable should be completed before the next warm season. Next, it was not thought to be so necessary as usual, on account of the frequent flushings it has received, by drawing off and letting on water in very large quantities every week. A very recent examination, however, shows that the deposit mentioned in the last Annual Report has again taken place, and must be removed within a short time.

The peculiar vegetable substance, occurring in patches of from one inch to one foot in diameter, and first discovered in the Aqueduct last year, when it was confined to the mile nearest the Lake, is now found in every part of the Aqueduct, from the Lake to the Brookline Reservoir. It is so tender, however, that the ordinary cleansing of the Aqueduct is sufficient to remove it. There is reason to believe that it grows very luxuriantly in comparatively still water, as will be mentioned under the head of *Iron Pipes.*

No new cracks have been discovered in the Aqueduct, except one about fifty feet long, on the side hill near Morse's Pond, where several others have taken place in former years. None of the old ones have given any trouble, except that at Webber's barn, where repairs were made in 1851, and mentioned in the Report for that year. This point will require a slight going over during the coming season.

The bridges, culverts, waste-weirs, and embankments, along the line of the aqueduct, and the iron pipe across Charles river, are all in good order.

The work of repairing the interior of the Aqueduct, mentioned in the last Annual Report, has been prosecuted unremittingly ever since, whenever it could be carried on; so that of the fourteen thousand feet which it was then thought advisable to go over, only three thousand remain to be done; and there is good reason to believe that this will be completed in May next.

That portion of it which has been done the longest gives all the satisfaction that was at first expected of it; and

there is every probability that it will prove permanently effectual, wherever the coating of English cement has been applied. At one time, when there was no English cement on hand, and when it was thought by one of the foremen that good American cement would answer the purpose, a trial was made. The usual precautions were taken, of washing the surface of the brick work with diluted nitro-sulphuric acid, of temporarily stopping even the smallest leaks with pieces of shingle, and of applying the cement immediately after being mixed; but the result was a failure, compared with the far superior effect of the English cement used in the same way. Our experience proves that the best American cement we have been able to procure will not, when newly laid, withstand the effect of pressure and percolation of water through it, in consequence of the solubility of some of its particles.

In no case has the water been shut off from the Aqueduct more than four days, on account of these repairs; and very rarely more than three days; as a longer period has been found to affect sensibly the high service in the City.

The Brookline Reservoir.

All the grounds and structures around this Reservoir have been kept in the same good condition they were in at the date of the last Annual Report.

The two large Meters there have not yet given that satisfaction in determining the consumption of water by the City, that was expected of them. Owing to their size and the position in which they are necessarily placed, it has been found quite difficult to make the valves lift, at the proper point to prevent the passage of water through them without being measured. The Air Chambers which have been resorted to, to remove this difficulty, and which promised to be so successful at first, have repeatedly failed and let in water. Still, one of these meters has run very smoothly for upwards of six months, and although it did not measure

accurately, according to the register, its error was uniform under the same head, and being once ascertained, could be used in correcting the registered quantities. In October, both the meters ran unusually well, and it was then that the measurements for every hour in the day were made, which will be found under the head of "Consumption of Water."

Mr. Huse, who has been so successful with his smaller meters, in this and in other cities, still thinks he can make them do all that was promised; and that he will be able to overcome the difficulty of making the Air Chambers sufficiently strong, and at the same time sufficiently light, to answer the purpose.

City Reservoirs.

These are all in the same condition that they were in at the date of the last Annual Report. The one on Beacon Hill is in perfect order; the one at South Boston has the same shabby fence between it and the grounds on Telegraph Hill; and the one at East Boston still leaks, but no more than it did formerly. Nothing has been done during the past year to stop this leak, because it was thought best to keep the repair force employed in the interior of the brick aqueduct.

The following tabular statements of the average depths of water in the Beacon Hill and South Boston Reservoirs for each month, as far as any records exist, in 1850, '51, '52, and '53, will be found very interesting, as showing the constant decline, from year to year, in the height at which the water stands in the City.

Average monthly depths of Water in Beacon Hill Reservoir, for the years 1850, 1851, 1852, *and* 1853.

Month.	1850.	1851.	1852.	1853.
January,	-	9.88	9.70	7.05
February,	-	10.56	10 20	5.84
March,	-	12.64	10 93	7.59
April,	12.31	12.08	11.29	8.61
May,	11.67	10.69	8.82	6.39
June,	10.80	10.99	8.61	6 05
July,	10.68	12.25	7.82	6.43
August,	11.17	10 67	7.82	7.05
September,	11.15	11.70	6.30	6.13
October,	11.06	11.72	8.05	7.29
November,	10 62	11.87	8 11	7.16
December,	9.61	11.33	5 24	6.76
Average for the year,	11.01	11.36	8.57	6.86

The apparent anomalies in this statement will be found explained in the last annual report.

Statement of the average depths of Water in the South Boston Reservoir.

Month.	1850.	1851.	1852.	1853.
January,	15 07	-	9 26	9.44
February,	15 27	†13.04	10.30	9.17
March,	14.88	14.80	11.31	10.35
April,	*14.05	14 00	11 80	11.27
May,	-	13 25	9.08	9.51
June,	-	6.68	8.52	7.31
July,	-	8.34	10.87	7.33
August,	-	9.77	12.11	7.68
September,	-	12.35	8.38	6.61
October,	-	13.15	10.89	6.84
November,	-	13 78	11 30	7.61
December,	-	11.90	10.00	6.67
Average,	-	11 91	10.32	8.31

* For 17 days in April, 1850.
† " 21 " in February, 1851.

The average depths of water in the South Boston Reservoir give a more correct idea of the constant decline going on in the height to which it ordinarily rises in the city, than those of the Beacon Hill Reservoir; but it should be remembered, that, during the past year, the height of water in the city has been about two feet less than it would have been, if no repairs had been made in the interior of the aqueduct.

These required the water to be drawn off, generally, for three days in each week, during which time the Brookline Reservoir fell, on an average, four feet.

The causes of the general decline, from year to year, in the surfaces of these reservoirs, will be explained under the head of "*Iron Pipes*" and "*Consumption of Water.*"

Iron Pipes.

The following statements of the whole amount of Pipes laid, up to the present time, and of the localities of those laid during the past year, have been prepared in the same form as those in the Annual Reports of 1851 and 1852.

Statement of the length of different sizes of pipes laid, and stopcocks put in, to Jan. 1st, 1854.

	DIAMETER OF PIPE IN INCHES.								
	36	30	24	20	16	12	6	4	Aggregate.
Feet of pipe laid in Brookline, Roxbury, and Boston proper,	19,355	30,332	5,773		5,714	47,885	201,936	68,860	
No. of stopcocks in the same,	4	7	10		12	95	410	172	
Feet of pipe laid in and for South Boston and Dorchester,				8,155		10,922	50,660	17,435	
No. of stopcocks in same,				3		25	68	24	
Feet of pipe laid in and for East Boston,				15,972	1,523	10,907	57,046	2,171	
No. of stopcocks in same,				5	3	17*	78	6	
Feet of pipe in Newton and Needham,		1,958							
No. of stopcocks in same,						1	1		
Totals. Length of pipe laid,	19,355	32,290	5,773	24,127	7,237	69,714	309,642	88,466	556,604 ft. or 105 miles and 2204 ft.
Number of stopcocks put in,	4	7	10	8	15	138	557	202	941

* Including one in branch for State Prison pipe.

If to the above aggregate length of pipes, be added the length of the hydrant branches and bends, about 18,960 feet, or a little more than 3 1-2 miles, the whole length of pipes, 4 inches and upwards in diameter, laid down in and for all parts of the City of Boston, will be a small fraction over 109 miles.

Statement of the location, size, and number of feet of distributing pipes laid in the year 1853.

In what Streets.	Between what Streets.	Diameter of pipe in inches.	Feet laid.	Remarks.
	Boston proper.			
Waltham, - -	Ringgold and Tremont, - -	12	275	
Leverett, - -	At Cragie's Bridge, - - -	12	76	
Tremont, - -	Northampton and Camden, - -	12	276	
Tremont, - -	Waltham and Hanson, - -	12	107	
	Total, 12 inch in Boston proper,	-	734	
Lenox, - -	Trainer Court and Tremont, -	6	55	
Hanson, - -	Ringgold and Tremont, - -	6	300	
Union Park, -	South side, - - - - -	6	244	
Union Park, -	North side, - - - - - -	6	340	
Chester Square, -	South side, - - - - -	6	475	
Chapman, - -	Washington and Shawmut Avenue,	6	235	
Troy, - - -	Harrison Avenue and Albany, -	6	262	
Concord, - -	Tremont and Shawmut Avenue, -	6	34	
Tremont, - -	Camden and Lenox, - - -	6	270	
City Wharf, -		6	119	
	Total, 6 inch in Boston proper,	-	2,334	
Sea, - - -	New Pipe Yard, - - - -	4	76	
Bumstead Court,	- - - - - - - -	4	100	
Rowe's Wharf, -	- - - - - - - -	4	303	
Constitution Wh'f,	- - - - - - - -	4	235	
	Total, 4 inch in Boston proper,	-	714	
	South Boston.			
Turnpike, - -	Sixth and Seventh, - - -	12	17	
	Total, 12 inch in South Boston,	-	17	
Third, - -	I and K, - - - - - -	6	105	
F, - - -	Sixth and Seventh, - - -	6	100	
Seventh, - -	F and Dorchester, - - -	6	265	
Sixth, - -	I and K, - - - - - -	6	200	
Boston Wharf, -	- - - - - - - -	6	235	
Sixth, - -	B and C, - - - - - -	6	94	
	Total, 6 inch in South Boston,	-	999	

Statement continued.

In what Streets.	Between what Streets.	Diameter of pipe in inches.	Feet laid.	Remarks.
Athens, - -	A and B, - - - - - -	4	84	
Boston Wharf, -	- - - - - - - -	4	264	
Gold, - - -	D and E, . - - - -	4	337	
	Total, 4 inch in South Boston,		685	
	East Boston.			
Condor, - -	Brooks and Meridian, - - -	12	850	
Meridian, - -	Condor and White. - - -	12	776	
White, - -	Meridian and Brooks, - - -	12	372	
Chelsea, - -	Putnam and Brooks, - - -	12	180	
Chelsea, - -	Marion and Brooks, - - -	12	66	
	Total, 12 inch in East Boston,	-	2,244	
Putnam, - -	Chelsea and Bennington, - -	6	347	
Jeffries, - -	Sumner and Marginal, - -	6	259	
Marginal, - -	Jeffries and Cottage, - - -	6	295	
Princeton, - -	Eagle and Putnam, - - -	6	400	
White, - -	Eutaw and Putnam, - - -	6	200	
Putnam, - -	White and Eagle, - - -	6	150	
Chelsea, - -	Eagle and Glendon, - - -	6	525	
White, - -	Brooks and Eutaw, - - -	6	138	
Marion, - -	Bennington and Chelsea, - -	6	850	
Border, - -	White and Eutaw, - - -	6	162	
Lexington, - -	Brooks and Eagle, - - -	6	1,650	
	Total, 6 inch in East Boston, -	-	4,976	
Cunard Wharf, -	- - - - - - - -	4	28	
White, - -	Junction of White and Eutaw, -	4	20	
Glendon, - -	Chelsea and Bremen, - - -	4	177	
Lombard's Wharf,	- - - - - - - -	4	162	
	Total, 4 inch in East Boston, -		387	

Recapitulation.

Section.	1853.	Diameter in inches. 12	6	4
Boston proper,	Total number of feet laid,	734	2,334	714
Stopcocks in same,			3	2
South Boston,	" " " "	17	999	685
Stopcocks in same,			1	2
East Boston,	" " " "	2,244	4,976	387
Stopcocks in same,		3	8	
	Sums of Pipes, - - - -	2,995	8,309	1,786
	" " Stopcocks, - - -	3	12	4

Service Pipes.

The whole number of service pipes put in, up to the present time, is 17,340; of which 687 were laid during 1853.

Statement of Service Pipes laid in 1853.

Diameter in inches.	Boston proper.		South Boston.		East Boston.		Total.	
	Number.	Length in feet.	Number.	Length in feet.	Number.	Length in feet.	Number.	Length in feet.
2	1	23						
1½								
1	6	218	6	483	6	788	18	1,489
¾	6	232	6	234	4	173	16	639
⅝	389	9,222	120	3,779	144	4,459	653	17,460
					Aggregate, - -		687	19,588

During a part of last year, the price of lead rose so high, that tin pipes of equal strength, (not of equal weight,) could be purchased for a cent less per running foot. As an unusual effort was made, about that time, to spread before the public, particularly in New York, objections against the use of lead for service pipes, quite a number of tin pipes were inserted when applications were made for the introduction of water into houses. It is, and has been for several years, the custom, according to your instructions, to lay tin or cast-iron service pipes, when objection is made to lead before the pipe is laid. There has always been a doubt, however, with regard to the durability of tin; and facts recently ascertained show, that in other places, pipes of this metal have not lasted two years. In one case, the metal was supposed to be impure; in another, the soil in which the pipe was laid acted injuriously upon it; so that these trials may not be fair ones. It should be remembered, however, that, as a metal, tin was known to the ancients; and yet there appear to be no cases of pipes made of it mentioned, in any published accounts of the Roman or other ancient Water Works.

The cast-iron service pipes, about 2500 of which were laid five or six years ago, will probably all have to be taken up, as they are rapidly filling with rust. A few days since,

one had to be taken out of Park Street on this account. As to unlined wrought iron pipes, they fill up more rapidly than the unlined cast-iron ones; but none of them have ever been laid by the City. Private individuals, however, who had objections to the use of lead, have laid them in their houses; and will, in every instance, sooner or later, be obliged to take them out.

Repairs of Pipes.

During the year 1853, the following leaks occurred, and were repaired.

Where.	Diameter of Pipe in inches.													
	36	30	24	20	16	12	6	4	2	1½	1	¾	⅝	Tot.
Boston proper,	6	4	1	1	1	6	21	19	5	48	10	5	159	286
South Boston,				3		2	2	2			1		14	24
East Boston,				5		3	6	3	2		4		12	35
Total,	6	4	1	9	1	11	29	24	7	48	15	5	185	345

Of the leaks that occurred in pipes 4 inches and upwards in diameter, 10 were caused by flaws or defects, (6 in the pipes, and 4 in the stopcocks,) not discovered in the proving press, 3 by settling of the earth, 1 by being drilled into by the Gas Company's workmen, by mistake, and 71 by loosening of the lead in the joints, as more fully explained below. Total, 85, or one in every 1.28 miles.

Of the leaks that occurred in the service and two-inch pipes, 112 were caused by flaws or defects, (65 in the pipes, 3 in the stopcocks, and 34 in the connections,) 5 by rats gnawing lead pipes, 15 by tenants, 15 by digging for sewers and gas, 11 by being accidentally struck by picks, and 83 mostly by settling of earth. Total, 241, or 1 to every 72 service pipes, nearly.

The table includes 17 service pipes that were opened to take out fish, and 2 to remove rust.

Statement of the number of Leaks, 1850–53.

Year.	Leaks in pipes of a diameter of		Total.
	4 inches and upwards.	Less than 4 inches.	
1850	32	72	104
1851	64	173	237
1852	82	241	323
1853	85	260	345

The foregoing statement shows that the annual rate of increase in the number of leaks is becoming very small, and it is hoped that it will before long change to a decrease. It is a gratifying fact, that of all the leaks that occurred in 1853, from defective lead joints, in pipes four inches and upwards in diameter, not one took place in any of the pipes laid during the last three years. Whether this is owing to the groove adopted to prevent the lead from working out, or to more faithful workmanship, more time is needed to decide.

As the statement shows that much the greater number of leaks occur in the service pipes, which other cities do not put in, and do not have to take care of, at their own expense, it may be asked, "what has Boston gained by incurring this expense?" The following statement will show that Boston has a larger water revenue in proportion to the population, than any of the other cities mentioned; and there is every reason to suppose that one great cause of this has been, the policy adopted by the City of inducing as many persons as possible to take the water, by laying the service pipes without charge to tenants. It should be remembered, however, that the average charge to each tenant in Boston is greater than it is in some other cities, particularly Philadelphia; but the quantity consumed is also greater here for each tenant, than in any other city except New York.

	Gross income, in dollars.			Population.
	1850.	1851.	1852.	1850.
New York, - - -	449,733.90	451,665 00	519 572 56	515,507
*Philadelphia, - -	132,592 31	140.313 50	151,323.12	187,195
Boston, - - - -	97,943.14	162,317 72	177,012.41	136,871
Cincinnati, - - -	74,381.41	80,448.37	91,442 44	115,436
Richmond, - - -		19,153.51		27,482

* Including only the districts supplied by the Fairmount Water Works.

The gross income of the nine Water Companies of London, in 1848, was about $2,125,000 (£425,000.) The population of that city, in that year, was about 2,200,000.

The deeply interesting and important subject of *accretions or rust in the interior of the iron pipes* has received much attention during the past year, and a personal inspection has been made, in company with Prof. Horsford, of the whole length of each of those across the Valley of Charles River. That examination, together with one made at the East Boston Reservoir, has led to farther suggestions as to the causes, and the rate and mode of growth, of these accretions, which will no doubt be communicated to you by Prof. Horsford himself.

The mechanical effect of these accretions, in retarding and diminishing the flow of water through the pipes, has become very sensible ; and much pains has been taken to ascertain its amount. By repeated observations on one of the pipes across the Charles River Valley, under different heads, of from two inches to two feet, it was found, that the loss of discharge, under the common head of six inches, was upwards of twenty per cent. of the known discharge of a new pipe of the same diameter. This pipe was then cleaned or scraped out, and the observations on its discharge repeated ; when it was found that its effective diameter was restored to thirty inches.

Similar observations on the quantity discharged by the 30-inch pipe, between the Brookline and Beacon Hill Reservoirs, show that it experiences, under the ordinary head of 8 feet, a loss of twenty per cent. But as, in reality, no less water is used on account of these accretions, it has to be delivered

at a level usually not less than three feet lower than a new and clean pipe would deliver it. [For an account of the details of these observations see Note at the end of this report.]

The cost of clearing out, rather imperfectly, the Charles River Valley pipe, which is 956 feet long, was $138.50, or about 14 1-2 cents a foot. Unfortunately, the pipe between the Brookline and Beacon Hill Reservoirs cannot be cleaned out in the same way at present; as the inconvenience to the city during the process would be intolerable, and the present diminished depth in the Beacon Hill and South Boston Reservoirs would be as nothing in comparison with it. It would be possible to do it, however, if man-holes were placed in this pipe every thousand feet; and if the tenants on the high service could be induced to depend for six or eight weeks upon the supply they might be able to retain in their cisterns or other vessels, for three days together in each week.

Stopcocks.

These, with one or two unimportant exceptions, are all believed to be in good order.

The wooden boxes that were first put around them are rapidly decaying, and many have had to be renewed. For the last two years all the new ones put in have been of Burnettized lumber, prepared in Lowell. It is too soon to make any comparison of their durability with that of the old ones; but there is very satisfactory ground for believing, that it will be fully sufficient to justify the additional expense of preparing the timber.

Hydrants.

During the year, 7 new hydrants were established in the City proper, 8 in South Boston, and 10 in East Boston. Altogether there have been established, up to the present time—

In Boston proper, - - - - - -	824
" South Boston, - - - - - -	192

In East Boston,	146
" Brookline,	1
" Roxbury,	4
" Charlestown,	11
" Chelsea,	7
Total,	1185

The precautions mentioned in the report for the year 1851 for keeping these hydrants constantly in order, continue to be taken; and the Chief Engineer of the Fire Department states, that in no case, during the year, were they found out of order when opened for use at fires.

New Pipe Yard.

During the past year, the new repair shop and pipe yard on Sea Street have been completed, and fitted up with almost every desirable convenience for carrying on the operations of the Pipe Department. It is not expected or believed that a mechanic will do any more work in a given time at the yard, than he would elsewhere; but the expense and loss of time in sending small jobs to and from other shops may be saved; and the work often more satisfactorily done. And as men must be kept winter and summer, to repair leaks, they can be usefully employed at the shop when there are no leaks to repair.

The long experience of Philadelphia, the economical management of whose Water Works has been and still is a model for other cities, confirms the propriety of the system adopted by the Board in this respect.

Statement of Pipes and other stock on hand, exclusive of Tools, January 1st, 1854.

	Diameters in inches.										
	36	30	24	20	16	12	6	4	2	1½	Jamaica Aqueduct. 10
No. of Pipes, - -	9	72	9	40	23	65	210	127	37	64	7
Blow off Branches,	2	4	-	-	-	-	-	-	-	-	-
Y Branches, - - -	-	1	-	-	1	1	2	-	-	-	-
3 Way Branches, -	6	2	-	-	4	16	10	3	34	-	-
4 Way Branches, -	-	2	1	-	1	4	5	-	-	-	-
Flange Pipes, - -	10	13	2	2	-	-	-	-	-	-	-
Sleeves, - - - - -	7	10	6	5	8	5	14	20	4	20	6
Caps, - - - - -	-	2	-	-	-	-	13	44	-	-	-
Reducers, - - - -	-	1	-	-	-	1	7	4	-	-	-
Bevelled Pipes, - -	-	-	-	2	-	-	2	6	-	-	-
Curved Pipes, - -	4	9	1	1	2	3	-	-	-	-	-
Quarter Turns, - -	-	-	-	-	-	3	12	3	-	-	2
Double Hubs, - -	-	-	-	7	9	-	-	-	-	-	-
Stop Cocks, - - -	4	2	2	1	3	2	2	-	2	-	2

Hydrants.

60 Old Kingston,
2 Wilmarth's,
10 Lowell,
3 Ballard Vale,
4 Long, (New York pattern.)

For Hydrants. 8 Bends, 10 Lengtheners, 36 Nipples, 27 Wharf Nipples, 47 Composition Nipples, 5 Frames and 6 Covers, 49 Lowell Screws, 44 Kingston Screws, 5 Spare Screws, 82 Caps, 7 Bend Rings, 14 Straps for Bend Rings, 29 Sets of Straps, 37 Straps, 33 Wastes, 75 Rings, 33 Wharf Cocks, 13 3-Way Cocks, 13 Wharf Couplings, 37 Valve Rods, 22 Bolts and Nuts, 12 Bottoms, 17 Seats, 10 Connections, Castings for 25 Hydrants, Lowell pattern.

For Stopcocks. Castings for 6 4-inch Stopcocks, 2 12-inch Valves, and 1 Screw, 1 6-inch Valve, 1 4-inch Valve, 1 Frame and Cover, 32 Cross Bars for large Stopcocks, 8 Gate Stands, 9 Rings, 1 Set Bolts, 600 Bolts for small Stopcocks, 4 large Composition Nuts, 65 brass Screws for Stopcock Flanges.

For Service Pipes. 474 Square Boxes, 13 T Boxes, 32 long Boxes, 1 Y Box, 5 flanges, Caps and Tubes, 34 2-inch Uprights, 180 Caps for 2-inch Uprights, 30 1-inch Air Cocks, 11 1-inch Flange Cocks, 63 3-4-inch Flange Cocks, 352 5-8-inch Flange Cocks, 19 5-8-inch Y Cocks, 19 5-8 T Cocks, 33 3-4-inch T Cocks, 13 1-inch T Cocks, 57 1-inch Main Cocks, 47 3-4-inch Main Cocks, 39 5-8-inch Main Cocks, 43 5-8-inch Straight Cocks, 23 5-8-inch Cocks, large size, for repairs, 17 1-inch Couplings, 39 3-4-inch Couplings, 31 5-8-inch Couplings.

Water Meters. 4 large size, (new,) 10 small size, (new,) 24 large size, (second hand,) 15 small size, (second hand,) 1 large size Power Meter.

Lead Pipe. 288 feet of 1-inch, 275 feet of 3-4-inch, 738 feet of 5-8-inch.

Block Tin Pipe. 297 feet of 3-4-inch, 75 feet of 5-8-inch.

Pig Lead, 936 lbs. *Sheet Lead,* 150 lbs. *Gasket,* 750 lbs.

Consumption of Water.

Daily average number of wine gallons, drawn from the Brookline Reservoir.

Month.	1849.	1850.	1851.	1852.	1853.
January, - -	1,700,000	5,181,700	7,233,700	8,280,900	8,050,500
February, - -	-	5,214,000	7,221,100	8,790,300	8,643,600
March, - - -	1,550,000	4 841,200	6,137,900	8,521,100	8,202 200
April, - - -	-	4,961,000	5,365,200	8,048,700	7,903,600
May, - - -	3,600,000	5 346,100	6,238,400	8,350.000	8,123,400
June, - - -	4,300,000	6,906,500	7,925 000	8,033,100	8,945,900
July, - - -	4,800,000	8,514,200	7,180,200	9,608,000	8,809,200
August, - - -	4,100,000	8,004,600	7,235,000	9,409,300	8,461,900
September, - -	4,800,000	6,585,500	7,230,600	7,920,000	8,640,700
October, - -	4,550,000	4,504,300	6,716,600	6,930,000	8,871,100
November, - -	3,800,000	4,960,500	6,473,500	6,637,900	8,624,700
December, - -	3,600,000	5,037,000	7,663,400	7,195,800	9,228,400
Average for the year,	3,680,000	5,837,900	6,883 800	8 125,800	8,542,300

* The observations for February and April, 1849, were too imperfect to base an estimate upon. The month of August was very wet. In the summers of 1849 and 1850, a great deal of water was used in flushing out the common sewers, and for the public fountains. In June, 1851, unusual waste was made in the City,

In addition to the explanations made in the note at the foot of the foregoing table, it might be mentioned, that the use of the hand-hose was far less frequent, last summer, than formerly. They were, in most instances, felt to be nuisances; and, having lost their novelty as playthings, will probably be confined much more, hereafter, to purposes of actual utility.

The consumption or waste of water, so far beyond what is known to be sufficient to meet all the wants of the City for every legitimate purpose, has received, since the date of the last annual report, more than usual attention. By the aid of the meters at the Brookline reservoir, the consumption all over our city, for each hour of the twenty-four, was obtained for two consecutive days, and that in the City proper only, for two days. The following statement shows the result during twenty-four hours for the whole City, and during an equal length of time for the City proper only.

Time, from	Consumption, in gallons, in the		Time, from	Consumption, in gallons, in the	
	Whole City.	City proper.		Whole City.	City proper.
P. M.		Oct. 20.	A. M.	Oct. 19.	Oct. 21.
7 to 8	-	252,000	10 to 11	461,000	434,000
8 to 9	-	240,000	11 to 12	463,000	427,000
9 to 10	-	234,000	P. M.		
10 to 11	-	214,000	12 to 1	461,000	422 000
11 to 12	-	197,000	1 to 2	421,000	391,000
A. M.	Oct. 19.	Oct. 21.	2 to 3	465,000	379,000
12 to 1	234,000	194,000	3 to 4	522,000	395,000
1 to 2	228,000	194,000	4 to 5	554,000	465,000
2 to 3	212,000	190,000	5 to 6	427,000	398,000
3 to 4	211,000	193,000	6 to 7	360,000	310,000
4 to 5	212,000	201,000	7 to 8	327,000	
5 to 6	270.000	226,000	8 to 9	295,000	
6 to 7	423.000	366,000	9 to 10	266.000	
7 to 8	463 000	407,000	10 to 11	248,000	
8 to 9	491,000	458.000	11 to 12	234,000	
9 to 10	488,000	424,000			
				8,736,000	7,611,000

to keep the Brookline Reservoir down. In December, the same year, the excessive cold caused a great deal of water to be wasted, to prevent pipes in houses from freezing. In December, 1852, the weather was very mild. The winter months in the early part of 1853 were much milder than the corresponding ones of 1852. In the spring and summer the pipes were flushed and "blown off" less frequently than usual. The months of July and August were wetter than ordinary.

The foregoing statement shows, that between midnight and 4 A. M., October 19th, the consumption in all parts of the City was 885,000 wine gallons, or at the rate of 5,310,000 gallons in 24 hours. It is utterly impossible that the half of this quantity could have been legitimately used at such a time; and yet four sets of observations, for as many nights, show that in the month of October, this rate of consumption or waste was without material variation. Trials made in other months, but with less care, give substantially the same result, except in very cold weather, when the consumption at night is very much increased, by letting the water run to prevent service pipes from freezing.

The enormous and unnecessary consumption at night, led to the supposition that there might be one or more large leaks, in the main pipes, near the wharves, and on this account undiscovered. In order to ascertain the truth of this, the City proper was divided into nine districts, and by means of the Beacon Hill Reservoir, the consumption in each district, between midnight and 4 A. M., was ascertained. These observations gave a result agreeing with those made at the Brookline Reservoir, as to the aggregate consumption or waste; and showed that it was not confined to any single district of the City proper, but was diffused all over it; and that there could be no very important undiscovered leaks in any of the mains or distributing pipes. They proved also, that no important leaks existed in the *flexible* or other pipes which cross the channels to South and East Boston.

The next step was, to examine the sewers during the same hours of the night. As most of these have their outlets near low water, favorable tides occurred only once a fortnight; and consequently these examinations were rapidly made, around the City proper. They showed that the waste was far less from the districts occupied by the best class of houses, than from those occupied by the poorest. For instance, the Beacon Street sewer was found to be entirely dry, and the Chestnut Street, and one or two other street drains, almost dry; while large quantities of water were discharged from several others in the northern and western portions of the City, es-

pecially from those in Cambridge and Canal Streets; and considerable amounts from nearly every one that was examined. It was not practicable to determine the quantities accurately then; but at a more favorable season it may be, except where spring water enters the sewers. Enough, however, was ascertained, to show that all the consumption of water was more than equalled by the discharge from the sewers.

Examinations of the kind already made, if followed up, together with those the Board have instructed the Water Registrar to make on the premises of water-takers, promise results of great importance, though much time and patience may be required to bring them about. It is very certain, that the steady increase of average daily consumption each year, will soon render it necessary, in a season of unusual drought, to resort to means not now under the control of the Board, to meet the demands of the City, unless something can be done to check the enormous waste now going on.

Compensating Reservoirs.

The Hopkinton and the Marlborough Reservoirs are in the same good condition they were in a year ago.

The estimated amount discharged from the Hopkinton Reservoir, between June 1st, and October 19th, was 704,937,000 gallons; and from the Marlborough Reservoir, during the same period, it was 708,775,000 gallons, being from both 1,413,712,000 gallons.

The estimated consumption by the City, during the same time, was 1,241,370,000 gallons, which caused a depression in the Lake of 38 1-2 inches, equivalent, for an average of 660 acres surface, to 692,462,000 gallons; leaving as the natural supply of the Lake 548,908,000 gallons, besides what was wasted through the natural outlet.

In consequence of the great amount of rain last year, together with the abandonment of the Middlesex canal, there was but little scarcity of water at the Billerica Mills, as shown by the report of the agent of the Board there.

Rain Gauges.

Observations with rain gauges were made by persons in the employ of the Water Board, and by others, the last year, in the same manner as the year before, as will be seen by the following table. The great differences in the quantity for December, at different places, show the difficulties experienced by the observers in measuring the equivalent of rain for the amount of snow that fell.

Monthly fall of Rain, in inches, in 1853.

Month.	Places and Observers.							
	Boston, by J. P. Hall.	Cambridge, by W. C. Bond.	Waltham, by E. Hobbs.	Lake Cochituate, by J. Vannevar.	Marlborough, by J. H. Maynard.	Hopkinton, by A. Wood.	Providence, by A. Caswell.	Lowell, by Lowell Man. Co.
January, -	2.44	3.88	2.18	3.68	3.77	2.23	4.27	1.52
February, -	5.30	5.70	5.36	6.56	5.20	6.67	5.75	6.06
March, - -	2.27	3.31	2.33	2.92	2.48	1.89	1.35	2.05
April, - -	3.78	3.69	3.34	3.80	3.42	3.54	5.05	3.45
May, - - -	5.63	6.45	6.29	6.32	4.98	5.89	4.95	5.40
June, - - -	0.30	0.55	0.95	0.56	1.35	1.02	0.90	0.60
July, - - -	3.64	3.02	2.72	2.84	2.87	3.12	6.37	2.36
August, - -	9.40	8.59	7.78	7.20	8.52	6.53	8.38	8.37
September,	3.80	5.95	4.50	5.44	4.59	4.76	3.80	4.32
October, -	3.92	3.49	2.30	4.56	4.64	5.00	4.15	4.30
November,	4.43	4.91	5.43	5.26	4.63	4.26	4.40	3.79
December,	3.95	4.29	1.86	6.59	4.82	2.96	3.90	1.70
Total, - -	48.86	53.83	45.04	55.86	51.27	47.87	53.27	43.92

Complaints of bad Water.

Very few complaints on this account have been made during the year; although there was no general flushing of the pipes, and much less "blowing off" at "dead ends" than usual. The enormous quantity of water passing through the pipes daily, it was thought, was quite sufficient to prevent stagnation, except at the ends of courts.

Surveys and Plans.

None of importance made during the year.

Lands belonging to the Water Works.

No change in them worthy of note since the date of the last Annual Report.

Jamaica Aqueduct.

This has received no special attention, nor has it given much trouble during the year ; and it continues to supply all who depend on it, in Roxbury.

Jamaica Pond has been kept low enough to prevent complaints from those who live on its borders.

Expenditures.

For these reference is made to the statement of the Clerk of the Water Board.

Which is respectfully submitted.

E. S. CHESBROUGH,

City Engineer.

Boston, January 5th, 1854.

(For note referred to on page 19, see end of Appendix.)

WATER REGISTRAR'S REPORT.

WATER OFFICE,
Boston, Jan. 2d, 1854.

THOMAS WETMORE, ESQ.,

President of the Cochituate Water Board.

SIR:—

The Water Registrar, in compliance with the provisions of the Ordinance, providing for the care and management of the Boston Water Works, passed October 31st, 1850, respectfully presents to the Cochituate Water Board, his Annual Report for the year 1853.

The total number of Water-Takers now entered for the year 1854, is 18,170, being an increase since January 1st, 1853, of 1308. Of this number, 259 are Public Buildings, &c., in which the water is used, but on which no assessments were made until the year 1853.

The total number of cases where the water has been shut off during the past year, is 1770. Of these, 1238 were for repairs; 532 were for non-payment of water rates.

The whole number of cases where the water has been let on during the year, is 2389. Of these, 1126 were cases which had been previously shut off for repairs; 459 were those which had been shut off for non-payment of water rates; and 804 were let on for the first time.

Repairs have been made upon the service-pipes, streets, sidewalks, &c., in 437 instances.

There have been *no abatements* made during the year.

The total amount received from December 31st, 1852, to January 2d, 1854, for water rates, is, - - - - - - - $196,352.32

Of the above, there was received for water used during the years 1851, and 1852, the sum of - - - - - -	$2,363.88
Leaving the receipts for water used during the year 1853, the sum of	193,988.44
Total Amount, - - - - - -	$196,352.32
In addition to the above, there has been received, for letting on water, in cases where it had been shut off for non-payment of water rates, - - - - - - - - - -	838.00

A detailed statement of the receipts for the year 1853, *is included in this Report.*

The total amount received during the year for the use of Jamaica Pond Water, is - -	2,010.61
This amount is included in the general account.	
The amount of assessments already made, for the year 1854, is - - - - - -	180,144.31
The estimated amount of income from the sales of water, during the year 1854, is - -	215,000.00
The expenditures in my department during the year 1853, have been, - - - - -	2,292.17
The items of this expenditure are as follows, viz:—	
Paid Wm. F. Davis, for services as clerk, - -	705.00
" Chas. L. Bancroft, for " " " - -	705.00
" Benjamin Heath, for services, - - -	152.00
" John H. Eastburn, for printing, - -	109.08
" Eayrs & Fairbanks, for books and stationery,	106.85
" Freeman Lane, for services, - - -	82.00
" Francis A. Bacon, " " - - -	76.00
" G. J. Stevens, " " - - -	76.00
" D. W. Child, " " - - -	74.00
Amount carried forward, - -	2,085.93

Amount brought forward,		-	2,085.93
Paid F. S. Kettelle,	for services,	-	72.00
" H. N. Whittlesey,	" "	-	64.00
" Samuel Huse,	" work on meters,	-	53.99
" J. A. Richards,	" books and postage,	-	12.25
" Stephen Maddox,	" washing towels,	-	4.00
Amount,		-	$2,292.17

By a vote of the City Council, passed January 13th, 1853, "The Water Registrar was directed, under the direction and control of the Cochituate Water Board, to assess the City of Boston, for the quantity of water used in the various Public Buildings belonging to said City, according to such tariff as the said Water Board might determine."

Subsequently, the Water Registrar was directed by the Water Board, to assess the City for the water used for all Public Purposes, in accordance with the tariff of the City Council, passed November 17th, 1850.

In compliance with the above orders, the City was assessed for the quantity of water used in all the Public Buildings, and for all Public Purposes, with the exception of that used for extinguishing fires, flushing sewers, and for the fountains and hydrants, on the Common and Public Squares. The use of water for the above named purposes, is undoubtedly of great value to the City, but in consequence of the irregular demand for water in these cases, it is impossible to make a correct estimate of the quantity required.

The total amount of assessments upon the City for the use of Cochituate Water during the year 1853, is $4,058.32.

These assessments were regularly entered on the books, the bills made out, and distributed, but were subsequently withdrawn by order of the Mayor, as no appropriation had been made to pay them.

A detailed statement of the Public Buildings supplied with Cochituate Water, with the amount assessed to each, is annexed to this Report.

Although it is impossible to make a correct estimate of the quantity of water required for extinguishing fires, yet it is not difficult to estimate the amount annually saved to the City, by the use of Cochituate Water, in the cost of maintaining its Fire Department.

In order to show this amount, I have prepared the following estimate of the relative cost of supporting a Fire Department, *with* and *without* the aid of Cochituate Water.

In 1847, the year previous to the introduction of Cochituate Water, the Boston Fire Department consisted of a Board of Engineers of 8 members, of eighteen engine companies, each company having 40 officers and members, of one hook and ladder company, having 24 officers and members, and one hose company having 18 officers and members, in all, 770 persons.

Capt. Wm. Barnicoat, the present efficient Chief Engineer of the Fire Department, informs me that in consequence of the growth of the City, and the increased size of buildings, which require protection, there would have been demanded at the present time, *without* the aid of Cochituate Water, a great addition to the above mentioned force. This addition to have made the Department equal to its present power, or at least, to have met the emergencies which *now* arise in case of fire, must have consisted of six engine companies, each company having 40 officers and members, of two hook and ladder companies, having 18 and 12 officers and members respectively, of one hose company having 18 officers and members, and at least, one additional Engineer. With this increase, the department would now consist of 1059 officers and members.

The Fire Department, at the present time, *with* the aid of Cochituate Water, consists of a Board of Engineers, of 9 members, of twelve engine companies, having 36 officers and members each, of three hook and ladder companies, having 24, 18, and 12 officers and members respectively, each, and of five hydrant companies, having 16 officers and members each, in all, 575 officers and members.

It may be well to state, that it was the custom of the City, previous to the introduction of Cochituate Water, to build at

least three reservoirs, annually, for the use of the Fire Department, at an average expense of $1500 per year.

Pay of the Department.

Engineers, $250 each per annum.

BOSTON.		EAST BOSTON.	
Foreman,	$150, ea. p'r an.	Foreman,	$75, ea. p'r an.
As't Foreman,	125, " " "	As't Foreman,	60, " " "
Clerks,	125, " " "	Clerks,	60, " " "
Stewards,	125, " " "	Stewards,	60, " " "
Members,	100, " " "	Members,	50, " " "

Estimated cost of maintaining the Boston Fire Department, during the year 1854, *with* and *without* the aid of Cochituate Water.

Without Cochituate Water.

9	Engineers,	*a* $250, per annum,	$2,250.00
24	Foremen,	*a* 150, " "	3,600.00
5	"	*a* 75, " "	375.00
24	As't Foremen,	*a* 125, " "	3,000.00
5	" "	*a* 60, " "	300.00
24	Clerks,	*a* 125, " "	3,000.00
5	"	*a* 60, " "	300.00
24	Stewards,	*a* 125, " "	3,000.00
5	"	*a* 60, " "	300.00
804	Members	*a* $100 p'r an	$80,400.00
130	"	*a* 50 " "	6,500.00
	Amount, - - -		86,900.00
	From which deduct 10 per cent. for vacancies, -		8,690.00
	Pay of Members, - -		78,210.00
	Pay of Officers and Members,		94,335.00
	Three Reservoirs, - - -		1,500.00
	Repairs and Contingencies, -		20,000.00
	Estimated cost *without* Cochituate Water,		$115,835,00

Amount brought forward,				$115,835.00
		With Cochituate Water.		
9	Engineers,	*a*$250, per annum,	$2,250.00	
16	Foremen,	*a*150, " "	2,400.00	
4	"	*a* 75, " "	300.00	
16	As't Foremen,	*a*125, " "	2,000.00	
4	" "	*a* 60, " "	240.00	
16	Clerks,	*a*125, " "	2,000.00	
4	"	*a* 60, " "	240.00	
16	Stewards,	*a*125, " "	2,000.00	
4	"	*a* 60, " "	240.00	
402	Members,	*a*$100, p'r an.	$40,200.00	
84	"	*a*50, " "	4,200.00	
	Amount, - - -		44,400.00	
	From which deduct 10 per cent. for vacancies, -		4,440.00	
	Pay of Members, - - -			39,960.00
	Pay of Officers and Members, -			51,630.00
	Repairs and Contingencies, -			12,500.00
	Estimated cost *with* Cochituate Water,			64,130.00
	Balance in favor of Cochituate Water, -			$51,705.00

By the foregoing estimate, it will be perceived that the use of Cochituate Water, for extinguishing fires, has made an annual saving to the City, in the cost of maintaining its Fire Department, of $51,705,00. This estimate, however, contains only such of the regular current expenses of the department, as are usually charged on the City books under the head of "Fire Department." The salaries of the Chief Engineer and Clerk of the Board of Engineers, are not included in the estimate, as they are charged under the head of "Salaries." As these however, would probably be the

same in either case, their omission does not effect the result. The interest on the cost of the additional land, buildings, and apparatus, which would have been required for the use of the department, if the Cochituate Water had not been introduced, should properly be added to the above amount, but as it is not known where the buildings would have been located, it is impossible to make a correct estimate of their cost. Sufficient, however, is shown in the estimate, to prove that the sum annually saved to the City in the cost of maintaining its Fire Department, together with the receipts for the use of water, and from other sources, will now fully equal the interest on the total cost of the Water Works.

By a vote of the Cochituate Water Board, passed January 26th, 1853, "The Water Registrar was directed to report to the Board, a plan of operation by which the places of waste of water in the City could be ascertained, and the waste prevented."

In compliance with the above order, a plan of operation was presented to the Board at its next meeting, February 2d. This plan was adopted, and men were employed to visit the premises of each water-taker, to examine, and report the number and kind of water fixtures in use. Subsequently, a report was made to the Board, containing a detailed statement of the number, and kind of water fixtures contained within the premises of water takers; also giving reasons why the consumption of water in the City is larger than the original estimate of the quantity required to meet the wants of the citizens, and making some suggestions relative to the means to be employed to reduce this consumption. The above mentioned report was sent by the Board to the City Council, and is now in the possession of the Joint Standing Committee on Water.

A detailed statement of the number, and kind of water fixtures contained within the premises of water-takers, is included in this Report.

STATEMENT, SHOWING THE NUMBER OF HOUSES, STORES, STEAM ENGINES, &c., IN THE CITY OF BOSTON, SUPPLIED WITH COCHITUATE WATER, TO THE FIRST OF JANUARY, 1854, WITH THE AMOUNT OF WATER RATES PAID FOR 1853.

1489	Dwelling Houses,	5.00	$7,445.00	
1678	" "	6.00	10,068.00	
1848	" "	7.00	12,936.00	
1881	" "	8.00	15,048.00	
1818	" "	9.00	16,362.00	
1509	" "	10.00	15,090.00	
901	" "	11.00	9,911.00	
596	" "	12.00	7,152.00	
345	" "	13.00	4,485.00	
220	" "	14.00	3,080.00	
145	" "	15.00	2,175.00	
109	" "	16.00	1,744.00	
67	" "	17.00	1,139.00	
74	" "	18.00	1,332.00	
61	" "	19.00	1,159.00	
51	" "	20.00	1,020.00	
34	" "	21.00	714.00	
38	" "	22.00	836.00	
19	" "	23.00	437.00	
40	" "	24.00	960.00	
188	" "	25.00	4,700.00	
1	" "	30.00	30.00	
1	" "	32.00	32.00	
519	" "		2,036.18	
13632				119,891.18
1492	Stores,	5.00	7,460.00	
4	"	6.00	24.00	
236	"	8.00	1,888.00	
1732	*Amounts carried forward,*		9,372.00	$119,891.18

1732	*Amounts brought forward,*		9,372.00	$119,891.18
4	Stores,	10.00	40.00	
8	"	13.00	104.00	
4	"	15.00	60.00	
180	"		542.06	
1928				10,118.06
398	Shops,	5.00	1,990.00	
6	"	6.00	36.00	
83	"	8.00	664.00	
6	"	10.00	60.00	
1	"	11.00	11.00	
7	"	15.00	105.00	
1	"	25.00	25.00	
89	"		306.99	
591				3,197.99
90	Offices,	5.00	450.00	
4	"	6.00	24.00	
18	"	8.00	144.00	
8	"	10.00	80.00	
1	"	13.00	13.00	
1	"	15.00	15.00	
15	"		48.18	
137				774.18
4	Banks,	5.00	20.00	
7	"	8.00	56.00	
1	"	10.00	10.00	
1	"	13.00	13.00	
1	"	15.00	15.00	
1	"	20.00	20.00	
3	"	25.00	75.00	
18	*Amounts carried forward,*		209.00	$133,981.41

18	*Amounts brought forward,*		209.00	$133,981.41
1	Bank,	30.00	30.00	
1	"	40.00	40.00	
20				279.00
2	Buildings,	13.00	26.00	
1	"	14.58	14.58	
3	"	15.00	45.00	
1	"	15.75	15.75	
3	"	20.00	60.00	
1	"	23.00	23.00	
3	"	25.00	75.00	
3	"	30.00	90.00	
1	"	35.00	35.00	
1	"	37.00	37.00	
1	"	40.00	40.00	
1	"	50.00	50.00	
1	"	95.63	95.63	
22				606.96
18	Churches,	5.00	90.00	
2	"	20.00	40.00	
8	"		14.16	
28				144.16
2	Halls,	5.00	10.00	
1	"	6.00	6.00	
1	"	8.00	8.00	
1	"	10.00	10.00	
4	"	15.00	60.00	
1	Private School,	1.67	1.67	
2	" "	5.00	10.00	
1	" "	15.00	15.00	
13				120.67
	Amount carried forward,			$135,132.20

	Amount brought forward,			$135,132.20
1	Theatre,	10.00	10.00	
1	"	35.00	35.00	
1	Gymnasium,	15.00	15.00	
1	Museum,	12.00	12.00	
1	Custom House,	150.00	150.00	
1	Hospital,	125.00	125.00	
1	Institution for Blind,	35.00	35.00	
1	Medical College,	30.00	30.00	
1	Post Office,	25.00	25.00	
1	State House,	20.00	20.00	
1	Eye & Ear Infirmary,	20.00	20.00	
1	Natural History Room,	10.00	10.00	
1	Asylum,	12.00	12.00	
1	"	15.00	15.00	
1	"	20.00	20.00	
1	"	25.00	25.00	
1	"	30.00	30.00	
1	"	200.00	200.00	
18				789.00
55	Market Stalls,	5.00	275.00	
5	" "	10.00	50.00	
1	Market,	15.00	15.00	
1	"	50.00	50.00	
1	"	65.00	65.00	
1	"	75.00	75.00	
1	"	107.00	107.00	
65				637.00
60	Cellars,	5.00	300.00	
8	"	8.00	64.00	
14	"		29.74	
82				393.74
	Amount carried forward,			$136,951.94

	Amount brought forward,			$136,951.94
3	Hotels,	12.00	36.00	
1	"	13.00	13.00	
1	"	14.62	14.62	
3	"	15.00	45.00	
4	"	18.00	72.00	
2	"	20.00	40.00	
3	"	21.00	63.00	
1	"	21.62	21.62	
1	"	22.50	22.50	
2	"	24.00	48.00	
3	"	25.00	75.00	
1	"	28.50	28.50	
5	"	30.00	150.00	
2	"	31.50	63.00	
2	"	33.00	66.00	
2	"	37.50	75.00	
2	"	45.00	90.00	
1	"	46.50	46.50	
1	"	52.50	52.50	
1	"	57.00	57.00	
4	"	60.00	240.00	
1	"	64.50	64.50	
1	"	67.50	67.50	
1	"	73.50	73.50	
1	"	78.00	78.00	
1	"	85.50	85.50	
1	"	90.00	90.00	
1	"	97.50	97.50	
1	"	99.75	99.75	
1	"	107.50	107.50	
1	"	118.50	118.50	
1	"	123.00	123.00	
1	"	124.50	124.50	
1	"	136.25	136.25	
1	"	138.00	138.00	
59	*Amounts carried forward,*		2,723.24	$136,951.94

59	*Amounts brought forward,*		2,723.24	$136,951.94
1	Hotel,	139.50	139.50	
1	"	151.50	151.50	
1	"	165.00	165.00	
1	"	182.50	182.50	
1	"	187.50	187.50	
1	"	320.50	320.50	
1	"	360.00	360.00	
1	"	360.50	360.50	
67				4,590.24
7	Restaurants,	5.00	35.00	
49	"	8.00	392.00	
8	"	10.00	80.00	
6	"	12.00	72.00	
9	"	15.00	135.00	
1	"	20.00	20.00	
1	"	24.00	24.00	
1	"	40.00	40.00	
10	"		39.59	
92				837.59
4	Saloons,	5.00	20.00	
68	"	8.00	544.00	
18	"	10.00	180.00	
1	"	11.00	11.00	
1	"	13.00	13.00	
1	"	14.00	14.00	
6	"	15.00	90.00	
1	"	17.00	17.00	
1	"	18.00	18.00	
1	"	20.00	20.00	
1	"	30.00	30.00	
21	"		74.74	
124				1,031.74
	Amount carried forward,			$143,411.51

	Amount brought forward,			$143,411.51
1	Club House,	10.00	10.00	
1	" "	25.00	25.00	
1	" "	50.00	50.00	
3				85.00
103	Stables,	3.00	309.00	
1	"	3.12	3.12	
2	"	3.33	6.66	
1	"	3.42	3.42	
1	"	3.67	3.67	
45	"	3.75	168.75	
5	"	4.00	20.00	
1	"	4.50	4.50	
1	"	4.69	4.69	
48	"	5.00	240.00	
1	"	5.42	5.42	
1	"	5.62	5.62	
1	"	5.75	5.75	
9	"	6.00	54.00	
28	"	6.25	175.00	
1	"	6.67	6.67	
23	"	7.50	172.50	
11	"	8.00	88.00	
1	"	8.33	8.33	
1	"	8.36	8.36	
16	"	8.75	140.00	
1	"	9.00	9.00	
1	"	9.33	9.33	
1	"	9.50	9.50	
20	"	10.00	200.00	
1	"	10.50	10.50	
1	"	11.00	11.00	
7	"	11.25	78.75	
2	"	12.00	24.00	
335	*Amounts carried forward,*		1,785.54	$143,496.51

35	*Amounts brought forward,*		1,785.54	143,496.51
12	Stables	12.50	150.00	
3	"	13.75	41.25	
3	"	14.00	42.00	
9	"	15.00	135.00	
1	"	16.25	16.25	
6	"	17.50	105.00	
1	"	18.00	18.00	
1	"	18.67	18.67	
1	"	18.75	18.75	
1	"	19.33	19.33	
9	"	20.00	180.00	
1	"	22.50	22.50	
4	"	24.00	96.00	
4	"	25.00	100.00	
1	"	26.00	26.00	
1	"	27.50	27.50	
5	"	28.00	140.00	
1	"	29.58	29.58	
5	"	30.00	150.00	
3	"	32.00	96.00	
2	"	32.50	65.00	
4	"	36.00	144.00	
1	"	37.50	37.50	
6	"	40.00	240.00	
1	"	41.17	41.17	
1	"	45.00	45.00	
1	"	46.67	46.67	
1	"	47.50	47.50	
1	"	48.00	48.00	
3	"	50.00	150.00	
1	"	55.00	55.00	
1	"	56.00	56.00	
2	"	60.00	120 00	
1	"	64.12	64.12	
7	"	70.00	490.00	
140	*Amounts carried forward,*		4,867.33	$143,496.51

140	*Amounts brought forward,*		4,367.33	$143,496.51
2	Stables,	72.00	144.00	
1	"	76.00	76.00	
2	"	80.00	160.00	
1	"	86.00	86.00	
1	"	90.00	90.00	
4	"	100.00	400.00	
1	"	118.00	118.00	
1	"	120.00	120.00	
1	"	130.00	130.00	
1	"	140.00	140.00	
1	"	144.00	144.00	
24	"		40.05	
480				6,515.38
1	Bathing House,	10.00	10.00	
2	" "	15.00	30.00	
1	" "	30.00	30.00	
1	" "	40.00	40.00	
2	" "	50.00	100.00	
1	" "	55.00	55.00	
1	" "	135.00	135.00	
9				400.00
3	Shops and Engines,	10.00	30.00	
1	" "	10.20	10.20	
1	" "	11.40	11.40	
1	" "	11.75	11.75	
1	" "	11.87	11.87	
1	" "	12.50	12.50	
1	" "	12.75	12.75	
1	" "	13.75	13.75	
1	" "	14.67	14.67	
1	" "	14.96	14.96	
12	*Amounts carried forward,*		143.85	$150,411.89

12	*Amounts brought forward,*		143.85	$150,411.89
1	Shop and Engine,	14.98	14.98	
2	" "	15.00	30.00	
1	" "	17.50	17.50	
1	" "	18.86	18.86	
1	" "	19.34	19.34	
2	" "	20.00	40.00	
1	" "	21.36	21.36	
1	" "	22.80	22.80	
2	" "	24.00	48.00	
2	" "	25.00	50.00	
1	" "	26.20	26.20	
2	" "	27.00	54.00	
1	" "	28.50	28.50	
1	" "	28.66	28.66	
1	" "	29.78	29.78	
1	" "	31.28	31.28	
1	" "	34.13	34.13	
1	" "	36.50	36.50	
1	" "	40.38	40.38	
1	" "	42.00	42.00	
1	" "	43.92	43.92	
1	" "	44.20	44.20	
1	" "	44.50	44.50	
1	" "	46.62	46.62	
1	" "	46.68	46.68	
1	" "	46.90	46.90	
2	" "	48.00	96.00	
1	" "	48.36	48.36	
1	" "	49.14	49.14	
2	" "	49.80	99.60	
1	" "	51.90	51.90	
1	" "	55.67	55.67	
1	" "	57.33	57.33	
1	" "	58.50	58.50	
1	" "	60.00	60.00	
54	*Amounts carried forward,*		1,627.44	$150,411.89

54	*Amounts brought forward,*		1,627.44	$150,411.89
1	Shop and Engine,	61.08	61.08	
1	" "	64.68	64.68	
1	" "	68.22	68.22	
1	" "	70.00	70.00	
1	" "	71.10	71.10	
1	" "	78.00	78.00	
1	" "	80.00	80.00	
1	" "	87.60	87.60	
1	" "	89.10	89.10	
1	" "	91.25	91.25	
1	" "	94.00	94.00	
1	" "	99.60	99.60	
1	" "	100.74	100.74	
1	" "	102.00	102.00	
1	" "	104.50	104.50	
1	" "	107.40	107.40	
1	" "	109.00	109.00	
1	" "	114.00	114.00	
2	" "	120.00	240.00	
1	" "	129.48	129.48	
1	" "	135.76	135.76	
1	" "	136.50	136.50	
1	" "	140.70	140.70	
1	" "	150.60	150.60	
1	" "	153.30	153.30	
1	" "	174.66	174.66	
1	" "	183.60	183.60	
1	" "	187.23	187.23	
1	" "	195.75	195.75	
1	" "	303.60	303.60	
10	" "		62.63	
95				5,413.52
1	Factory and Engine,	17.50	17.50	
1	" "	22.26	22.26	
2	*Amounts carried forward,*		39.76	$155,825.41

2	*Amounts brought forward,*			39.76	$155,825.41
1	Factory and Engine,		22.40	22.40	
1	"	"	32.00	32.00	
1	"	"	40.50	40.50	
1	"	"	47.50	47.50	
1	"	"	54.24	54.24	
1	"	"	69.84	69.84	
1	"	"	72.00	72.00	
1	"	"	78.00	78.00	
1	"	"	86.40	86.40	
1	"	"	89.02	89.02	
1	"	"	111.60	111.60	
1	"	"	104.22	104.22	
1	"	"	113.10	113.10	
1	"	"	125.00	125.00	
1	"	"	132.96	132.96	
1	"	"	133.84	133.84	
1	"	"	160.00	160.00	
1	"	"	288.00	288.00	
1	"	"	300.00	300.00	
1	"	"	308.40	308.40	
1	"	"	339.72	339.72	
1	"	"	557.70	557.70	
1	"	"	1,587.60	1,587.60	
25					4,893.80
1	Foundry and Engine,		11.00	11.00	
1	"	"	48.00	48.00	
1	"	"	65.28	65.28	
1	"	"	80.40	80.40	
1	"	"	121.40	121.40	
1	"	"	461.74	461.74	
6					787.82
	Amount carried forward,				$161,507.03

	Amount brought forward,					$161,507.03
1	Printing Office and					
			Engine,	12.19	12.19	
1	"	"	"	16.00	16.00	
1	"	"	"	18.28	18.28	
1	"	"	"	18.74	18.74	
1	"	"	"	20.00	20.00	
1	"	"	"	22.68	22.68	
1	"	"	"	25.00	25.00	
1	"	"	"	29.28	29.28	
1	"	"	"	35.74	35.74	
1	"	"	"	40.80	40.80	
1	"	"	"	42.62	42.62	
1	"	"	"	73.76	73.76	
1	"	"	"	83.24	83.24	
1	"	"	"	103.86	103.86	
14						542.19
1	Factory,			5.00	5.00	
1	"			8.00	8.00	
2	"			10.00	20.00	
2	"			12.00	24.00	
11	"			15.00	165.00	
1	"			22.50	22.50	
2	"			30.00	60.00	
1	"			30.14	30.14	
1	"			45.00	45.00	
1	"			50.00	50.00	
1	"			71.04	71.04	
1	"			110.00	110.00	
1	"			142.67	142.67	
1	"			343.76	343.76	
27						1,097.11
	Amount carried forward,					$163,146.33

	Amount brought forward,			$163,146.33
1	Sugar Refinery,	1,966.56	1,966 56	
1	" "	1,736.16	1,736.16	
2				3,702.72
1	Rolling Mill,	1,921.50	1,921.50	
1	" "	625.44	625.44	
1	Forge,	362.85	362.85	
3				2,909.79
22	Printing Offices,	6.00	132.00	
2	" "	8.00	16.00	
8	" "	10.00	80.00	
2	" "	12.00	24.00	
1	" "	24.00	24.00	
35				276.00
1	Distillery,	60.00	60.00	
1	"	80.00	80.00	
1	"	90.00	90.00	
1	"	126.67	126.67	
1	"	169.74	169.74	
1	"	177.16	177.16	
1	"	480.84	480.84	
1	"	546.72	546.72	
1	"	720.00	720.00	
1	Brewery,	15.00	15.00	
1	"	25.00	25.00	
1	"	169.00	169.00	
12				2,660.13
1	Bleachery,	5.00	5.00	
1	"	8.00	8.00	
2	*Amounts carried forward,*		13.00	$172,694.97

2	*Amount brought forward,*		13.00	$172,694.97
2	Bleacheries,	10.00	20.00	
1	Laundry,	10.00	10.00	
1	"	60.00	60.00	
1	Pottery,	30.00	30.00	
1	Dye House,	60.00	60.00	
8				193.00
1	Bakery,	2.08	2.08	
42	"	5.00	210.00	
2	"	8.00	16.00	
3	"	10.00	30.00	
1	"	15.00	15.00	
49				273.08
2	Bacon Works,	10.00	20.00	
1	" "	15.00	15.00	
3				35.00
3	Ship Yards,	15.00	45.00	
2	" "	20.00	40.00	
1	Sectional Dock,	14.00	14.00	
6				99.00
928	Hose,	3.00	2,784.00	
3	"	10.00	30.00	
1	"	15.00	15.00	
932				2,829.00
5	Fountains,	3.00	15.00	
3	"	5.00	15.00	
8	"	6.00	48.00	
16	*Amounts carried forward,*		78.00	$176,124.05

16	*Amounts brought forward,*		78.00	$176,124.05
2	Fountains,	8.00	16.00	
2	"	9.00	18.00	
1	"	12.00	12.00	
2	"	13.00	26.00	
3	"	15.00	45.00	
2	"	25.00	50.00	
28				245.00
1	Railroad Company,	2,245.88	2,245.88	
1	" "	1,188.14	1,188.14	
1	" "	918.57	918.57	
1	" "	783.20	783.20	
1	" "	697.56	697.56	
1	" "	583.85	583.85	
1	" "	95.00	95.00	
1	Freight House,	15.00	15.00	
8				6,527.20
1	East Boston Ferry Co.,	570.84	570.84	
1	Chelsea " "	435.69	435.69	
2				1,006.53
1	Cunard Steamship Co.,	600.00	600.00	
1	Steamboat,	404.95	404.95	
1	"	285.18	285.18	
1	"	190.48	190.48	
1	"	184.20	184.20	
2	"	185.63	371.26	
2	"	168.75	337.50	
1	"	176.85	176.85	
1	"	12.333	123.33	
1	"	123.20	123.20	
12	*Amounts carried forward,*		2,796.95	$183,902.78

12	*Amounts brought forward,*		2,796.95	$183,902.78
1	Steamboat,	100.38	100.38	
1	"	94.32	94.32	
1	"	59.16	59.16	
1	"	5.00	5.00	
16				3,055.81
	Contractors for supplying shipping,		3,900.06	
	Street Waterers,		655.88	
	Building Purposes,		609.93	
	Proprietors of Boston Traveller,		535.51	
	Sewall Day & Co.,		500.00	
	Mill Dam Co.,		300.00	
	Boston Gas Light Co.,		300.00	
	East Boston Gas Co.,		109.37	
	South Boston " "		105.10	
	Mechanics Fair,		14.00	
				7,029.85
	Amount of Water Rates,			$193,988.44

STATEMENT, SHOWING THE NUMBER OF CITY BUILDINGS, AND OTHER PUBLIC PLACES, SUPPLIED WITH COCHITUATE WATER, TO THE FIRST OF JANUARY, 1854, WITH THE AMOUNT OF WATER RATES ASSESSED TO EACH, FOR 1853.

1	Latin School,	15.00	15.00
1	English High School,	15.00	15.00
1	Normal School,	15.00	15.00
19	Grammar Schools,	15.00	285.00
3	Primary Schools,	10.00	30.00
179	" "	5.00	895.00
3	" " (6 months,)	2.50	7.50
4	" " (3 ")	1.25	5.00
12	Engine Houses,	15.00	180.00
5	Hose Carriage Houses,	15.00	75.00
3	Hook and Ladder Houses,	15.00	45.00
2	Watch Houses,	15.00	30.00
5	" "	10.00	50.00
1	City Stable, (Harrison Avenue,)	70.00	70.00
1	" " (Commercial St.,)	30.00	30.00
3	Fire Alarm Motors, (6 months,)	2.50	7.50
	Court House, - - - - - -		95.00
	City Hall, - - - - - -		50.00
	Faneuil Hall, - - - - - -		40.00
	City Building, - - - - - -		37.50
	Probate Office, - - - - - -		10.00
	Office at City Scales, - - - - -		8.00
	Dead House, - - - - - -		8.00
	Public Library, - - - - - -		5.00
	House of Correction, - - - - -		500.00
	House of Industry, - - - - -		225.00
	Lunatic Hospital, - - - - -		225.00
	Jail for Suffolk County, - - - -		225.00
	House of Reformation, - - - -		50.00
	Amount carried forward, - - -		$3,233.50

Amount brought forward,	$3,233.50
Faneuil Hall Market, (for Urinals, &c.,) -	70.00
Street Sprinkling, - - - - - -	400.00
Offal Station, - - - - - - -	150.00
Watering Tremont Road, - - - -	129.82
Common Sewers, (for Making Mortar, &c.,)	75.00
Amount, - - - - - -	$4,058.32

STATEMENT, SHOWING THE NUMBER AND KIND OF WATER FIXTURES, CONTAINED WITHIN THE PREMISES OF WATER TAKERS, IN THE CITY OF BOSTON, TO THE FIRST OF MARCH, 1853.

3968 Taps. *These have no connection with any drain or sewer.*
19287 Sinks.
3149 Wash Hand Basins.
1838 Bathing Tubs. *Most of these have shower baths attached.*
1622 Pan Water Closets.
698 Hopper " "
159 Self-acting" "
218 Urinals.
476 Wash Tubs. *These are permanently attached to the building.*
14 Shower Baths. *These are in houses where there is no tub.*
9 Hydraulic Rams.
312 Private Hydrants.
1123 Places having hot water fixtures.

All of the above, with the exception of the 3968 *Taps, are connected by drains, with the common sewers.*

The foregoing Report is respectfully submitted.

J. AVERY RICHARDS,
Water Registrar.

PROFESSOR HORSFORD'S COMMUNICATION.

THOMAS WETMORE, ESQ.,

President of the Cochituate Water Board.

SIR,—

The incrustation of the water pipes has continued to occupy my attention during the past year.

It is a satisfaction to be able to state, after a comparison of the casts of the tubercles taken three years since, with the tubercles observed but a few weeks ago, that the growth is less rapid than at first.

The persuasion that galvanic action is prominent among the agencies in the production of tubercles, has been strengthened by the observations of the last year.

In November last the City Engineer enabled me to pass through the pipes at Newton, Lower Falls—a length of about two thousand feet in all. A better opportunity than I have before enjoyed, was thus afforded of seeing and comparing extensive surfaces of pipe. Of the interesting things observed in the excursion, and which may throw light on the occult agencies producing the accretions, several may be worthy of mention.

In a few instances the sections of pipe were covered throughout with tubercles. In the majority, they were nearly covered. In a very few instances, there were pipes covered to the extent of from about one-eighth to one-fourth.

In one section of pipe, for the most part covered with accretions, there were two strips of vacant space, about an inch in width, extending parallel to the axis, from end to end.

In several there were similar strips, of less length.

In several others there were rings of tubercles, as if, the

pipes being cast upright, there had been a difference in the casting material of the upper and lower parts, or in the fashioning of the core.

Some sections had patches of large tubercles, and then patches of exceedingly small ones.

The joints of pipes, where closely fitting, were entirely filled with tubercles, which projected above the surrounding level of accretions, and was, beside, uniformly soft, and in some places porous and cavernous. In some instances there had been shrinking of the incrustations over the lead joints, displaying a continuous crack.

This observed superior development of the tubercles at the junction of lead and iron, is in keeping with the facts noticed last year at Dover Street, and earlier elsewhere, that the contact of a metal of inferior susceptibility to oxidation, promotes the growth of the accretions.

Two sections of pipe in the East Boston Reservoir have so few and such small accretions, that, compared with other sections, of the same diameter, as at Chelsea Bridge, they may be considered as quite free. One of them is in contact with another pipe which is severely corroded. The connection of the other is not visible.

These sections and all the others of the 20-inch pipe employed to conduct the water to the East Boston Reservoir, were, I understand, cast at Alger's South Boston Foundry. On inquiry at the foundry, I found there was a peculiarity in the construction of the cores, around which these sections were cast.

Ordinarily the core is a hollow, cast-iron cylinder, perforated with numerous holes, and wound with hay-rope, over which there is a coat of loam. With the exception of the sections in question, all the 20-inch pipe cast at Alger's foundry were made upon such a core. The particular sections were cast around what is called a brick core; that is, a core having within the loam, instead of a hay-rope and hollow cylinder, a brick base for the coating of loam.

The significance of this contrast in modes of casting, and

corresponding difference in the susceptibility to oxidation and accretion, would be more obvious, were it not that of the 36-inch pipes made at the West Point Foundry, *all* of them cast on hay cores, *some* are free, or nearly so, from accretions.

Ordinary cast-iron contains, beside carbon, silicon, sulphur, phosphorus, sometimes magnesium, aluminum, arsenic, zinc, titanium, and manganese; and more seldom other substances. The chief foreign ingredient is carbon, which in the white cast iron is all chemically combined with the iron. In the grey iron a part of it is in the form of graphite. The maximum of carbon is less than 6 per cent. The range in white iron is from 3 1-2 to 5 3-4 per cent.; that in the grey iron, from 3 1-5 to 4 3-5 per cent. Various circumstances conspire to produce the white iron, such as sudden cooling, by moist sand or iron moulds, large proportions of sulphur, phosphorus, or manganese, which tend to prevent the separation of graphite,—reduced quantity of carbon, and too low a temperature. (Scheerer.)

Now the separation of graphite will give an iron wanting in homogeneity. Such an iron will give rise to galvanic action, and such action is known to favor the growth of tubercles.

There seem to be no means of ascertaining, with any degree of precision, where the iron was derived from, of which the separate sections are composed. At the time they were produced the market furnished pig iron from Pennsylvania, Salisbury, Stockbridge, Scotland, England, and various other sources. There remained the analytical examination of the pipes only. It was thought there might be some indication in the amount of carbon and other foreign substances, each as compared with the other or the whole, which might shed the desired light. Analyses were accordingly made of specimens of incrusted iron derived from various sources. For specimens, some years employed in the distribution of Croton water, and for others, similarly employed in Baltimore, both of which bore tubercles, the latter more than the former, but both much inferior to the average of Cochituate iron pipes, I am indebted to the President of the Water Board. Beside

these, specimens were taken of the pipe *not acted on* in the East Boston Reservoir, and also of the section in immediate connection, *acted* on, and also of pipe in Boston displaying great severity of action.

ANALYSIS OF IRON PIPES.

SPECIFIC GRAVITY.

The specific gravity was determined by weighing the iron accurately in the air, and then plunging it in water, at 9° C., and weighing again. The loss it sustained in the water compared with the absolute weight of the substance gave the specific gravity.

BOSTON PIPE.

Weight of iron = 43.3166 grammes.
Loss in water = 6.1878 "
Specific gravity = 7.000

NEW YORK PIPE.

Weight of iron = 26.5762 gr.
Loss in water = 3.9405 "
Specific gravity = 6.728

BALTIMORE PIPE.

Weight of iron = 21.1661 gr.
Loss of water = 3.0560 "
Specific gravity = 6.926

EAST BOSTON, *not acted on.*

Weight of iron = 6.0885 gr.
Loss in water = 0.9000 "
Specific gravity = 6.7660

EAST BOSTON, *acted on.*

Weight of iron = 2.9439 gr.
Loss in water = 0.4240 "
Specific gravity = 6.943.

The iron was dissolved in hydrochloric acid, with addition of a little nitric acid. The insoluble residue was washed

out, dried, weighed, a part of it examined with a microscope, and another part burned with chromate of lead to determine the carbon.

Boston Pipe, having large incrustations, and coarse grained. 5.2925 gr., substance gave 7.183 gr. oxide of iron = 95. per cent. of metallic iron. It left a residue of 0.3990 gr. = 7.54 per cent. Of this residue 0.3562 gr. gave by combustion 0.585 gr. carbonic acid = 0.1595 gr. = 3.39 per cent. of carbon in the whole.

New York Pipe, having small incrustations. 6.3367 substance gave 8.493 gr. oxide of iron = 93.82 per cent. metallic iron. It left a residue of 0.5305 gr. = 8.37 per cent. Of this residue 0.4917 gr. gave, by combustion with chromate of lead, 0.697 gr. carbonic acid, corresponding to 0.1901 gr. or 3.23 per cent. of carbon in the whole.

Baltimore Pipe, having larger incrustations than New York, but less than Boston. 7.8945 gr. substance gave 10.479 gr. oxide of iron = 92.92 per cent. of metallic iron. It left a residue of 0.9145 gr. = 11.58 per cent. Of this residue 0.4832 gr. gave by combustion 0.461 gr. carbonic acid = 0.1257 gr. or 3.02 per cent. carbon in the whole.

East Boston Pipe, No. I, *not acted on*, or having very small incrustations. 5.3262 gr. substance gave 7.222 gr. oxide of iron = 94.91 per cent. of metallic iron. It left 0.4000 gr. residue = 7.51 per cent. Of this residue 0.3635 gr. gave by combustion 0.5945 gr. carbonic acid = 0.1623 gr. = 3.34 per cent. of carbon in the whole.

East Boston Pipe, No. II, *acted on*, only less than the Boston sample above. 5.321 gr. substance gave 7.218 gr. oxide of iron = 94.96 per cent. of metallic iron. It left a residue of 0.3975 gr. = 7.48 per cent. Of this residue 0.3668 gr. gave by combustion 0.584 gr. carbonic acid = 0.1593 gr. or 3.24 per cent. of carbon in the whole.

I. Placing the results in one hundred parts, we have:

	Metallic Iron.	Inorganic Residue.	Carbon.
Boston pipe, - - -	95.00	4.15	3.39
New York pipe, - - -	93.82	5.14	3.23
Baltimore pipe, - - -	92.92	8.56	3.02
East Boston pipe, No. I, -	94.91	4.17	3.34
East Boston pipe, No. II, -	94.96	4.24	3.24

The excess over one hundred parts is due to the oxidation of the silicon, aluminum, and other ingredients, in the iron, not including the carbon.

The percentage of carbon in all is below the quantity required for a homogeneous carburet, but the difference does not seem to obey any law connected with the prevalence of accretions.

II. On microscopic examination of the residues, the proportion of graphite on the one hand, and of silica and other insoluble matters on the other, was estimated by the eye to be about as follows:—

	Graphite.	Silica, etc.
East Boston, No. II, - -	3-4	1-4
Boston, - - - - -	1-2	1-2
East Boston, No. I, - - -	1-3	2-3
Baltimore, - - - -	1-4	3-4
New York, - - - -	1-4	3-4

III. On microscopic examination of the different samples before dissolving, the grain and lustre appeared as follows:—

East Boston, No. II, Small grain, dull lead glance.
Boston, - - Large grain, lamellar texture, strong, resinous lustre, lead glance.
East Boston, No. I, Small grain, dull lead glance.
Baltimore, - - Small grain, lead glance, brighter than the preceding.
New York, - - Small grain, greyish, lustre of plumbago.

IV. After keeping the samples of iron under water for thirty-six hours, they were exposed, still moist, to the air,

and the rapidity of oxidation estimated from the change in color, in given times. This estimate gave the following relations :—

Boston, - -	Most rapidily.
New York, - -	Next "
East Boston, No. II,	" "
Baltimore, - -	" "
East Boston, No. I,	" "

On comparing the scale of accretion, or rapidity of formation of tubercles, with any of the foregoing tables, there will be found no principle of correspondence.

V. The case is different, however, with the scale of specific gravities, which is as follows :—

	Specific Gravity.	Scale of Accretion.
Boston pipe, - - -	7.000	5.
East Boston, No. I, - -	6.943	4.
Baltimore, - - -	6.926	3.
East Boston, No. II, - -	6.766	2.
New York, - - -	6.728	1.

This coincidence is sufficiently striking to afford ground for a new suite of observations in the direction which it indicates, and which I shall hope to be able to carry forward in the course of the coming year.

What can be done to arrest the Accretions?

In the past year, I have examined sheet iron pipes coated exteriorly and interiorly with hydraulic cement, which had been seven years in use for distributing water. It was in all respects entirely free from corrosion. I have been informed that at Saratoga such pipes have been in use fourteen years. It is obvious that the protection must be perfect, or such slender pipe would have been speedily consumed. It is not so obvious, however, that adhesion to cast-iron pipes might be as easily secured. In September last, a small space of iron pipe in use was freed of tubercles and coated with hydraulic cement. At the end of November there was no indication

that the protection had been imperfect. Though this result may not be entitled to much weight by itself, taken in connection with the experiments with sheet iron pipe coated elsewhere with cement, it would at least justify a repetition of the experiment upon a more extended scale.

The fears entertained, by Mallet, in regard to the use of hydraulic cement, whose observations are cited in the last year's report of the President, could not have been based upon experiment. We have abundant evidence that the current in Cochituate pipes is utterly inadequate to the removal of compact hydraulic cement. It does not even remove the friable and much less firm tubercles. As to the durability of the protection, Mallet had probably before him results of a mere wash of the cement. The point of solicitude would seem to be, the successful attachment of the cement to the rough surface. Whether this will be determined favorably will doubtless be shown in the course of the coming year.

Arrangements have been made to prepare, in the coming year, cast iron, for experiment in Cochituate water, under such a variety of well defined conditions, that I cannot doubt, the true cause of accretions will be developed, and the mode of preventing their occurrence ultimately ascertained.

Respectfully submitted.

E. N. HORSFORD.

Cambridge, Feb. 7, 1854.

Note referred to on page 19 *of Appendix.*

In order to ascertain the effect of the accretions in the 30-inch pipes across the Charles River Valley, a weir, 4.38 feet long and 3 feet high, was placed in the aqueduct, 50 feet below the East or Effluent Pipe-Chamber. The channel above the weir, for 12 feet, was 4.38 feet wide, thus avoiding contraction.

The length of the pipe experimented upon (the most southerly of the two) was 979 feet. In order to avoid errors in the measurement of the head, arising from the effect of eddies in the West or Influent Pipe-Chamber, gauges were connected with the pipe outside of the Chambers. These connections were made at similar bends in each end of the pipes, and it was consequently supposed that whatever errors, due to the effect of a rapid current in the main pipe, there might be in the heights, as shown by the gauge at one end, would be counterbalanced by equal errors at the other end; but, at the time, there appeared to be no way of proving this.

By means of a 12-inch branch from the lowest part of the main pipe not experimented upon, the height of water in the West Pipe-Chamber was regulated so as to remain stationary at different levels.

The following observations were made before the pipe was cleaned out:

Head as shown by the height of water in the Pipe Chambers.	Head as shown by the gauges at each end of the Pipes.	Height of water on the Weir.
0.225	0.225 ft.	0.440 ft.
0.700	0.643 "	0.620 "
2.780	2.340 "	0.965 "

The following were made after the pipe was cleaned out:

0.155	0.155	0.455
0.575	0.525	0.695
1.625	1.450	1.000

The unexpectedly great difference, at the higher velocities, between the heads as shown by the heights of water in the Pipe-Chambers, and by the gauges at the ends of the pipes, prove that eddies formed in the West Pipe-Chamber extend their influence for some distance into the pipes.

Although we were thus disappointed in obtaining the exact heads required to overcome friction in the pipe, under different velocities, before and after it was cleaned out, the heads actually observed justify all that is said in the report relative to the effect of accretions in diminishing the amount of discharge.

The loss in the discharge through the 30-inch pipe between the Brookline and Beacon Hill Reservoirs was determined by measuring the actual discharge, and comparing it with what Prony's exact formula would give for a clean pipe of the same diameter and length, with the same head. Unfortunately, no record can be found of the actual discharge through this pipe when it was first laid.

JU 27 '39

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